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been sent by Smithsonian
for some time; then wrote
to Smithsonian & got it
by mail.
Acknowledgement ...

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Francisco, Cal.
1882.

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Geo Davidson

Oct 12/82

Ackn.

ACCOUNT

OF

OBSERVATIONS

OF

THE TRANSIT OF VENUS,

1874, December 8,

MADE UNDER THE AUTHORITY OF

THE BRITISH GOVERNMENT:

AND OF

THE REDUCTION OF THE OBSERVATIONS.

EDITED BY

SIR GEORGE BIDDELL AIRY, K.C.B.,

ASTRONOMER ROYAL.

PRINTED FOR HER MAJESTY'S STATIONERY OFFICE,
UNDER THE AUTHORITY OF
THE LORDS COMMISSIONERS OF HER MAJESTY'S TREASURY.

1881.

INDEX.

INTRODUCTION.

THE first occasion, I believe, in late years, on which the attention of the British public was pointedly called to the approaching Transits of Venus, was my communication to the Royal Astronomical Society, dated 1857, April 8, "On the means which will be available for correcting the measure of the Sun's distance in the next 25 years." This paper was not limited to the consideration of Transits of Venus, a part of it being devoted to the Oppositions of Mars. Much attention, however, was given to the selection of stations for observation of the Transits both of 1874 and of 1882.

On 1864, May 5, I addressed another communication to the same body, relating only to the Transit of 1882, and to the necessity for a reconnoissance of antarctic countries if an observation with the Sun below the pole should be contemplated.

On 1868, October 10, I began a correspondence with the Hydrographer, Captain (now Sir George) Richards, on the general subject.

On 1868, December 11, I read a communication to the Royal Astronomical Society, "On the Preparatory Arrangements which will be necessary for efficient observation of the Transits of Venus in the years 1874 and 1882." This paper was accompanied with eight maps of the regions which appeared proper for the observations of Ingress and Egress, accelerated and retarded by Parallax, in the two Transits. An active discussion followed, in which the Hydrographer and several Navy Officers took a prominent part.

On 1869, February 15, I sent certain papers to the Secretary of the Admiralty; on April 9 I wrote more formally with Estimate of Expense of Instruments; and on May 25 I sent a printed copy of the discussion of 1868, December 11, including also a paper by Mr. De La Rue on the application of Photography. About the same time an Estimate was furnished by the Hydrographer for expenses of travelling, residences, &c. [Each of these estimates proved ultimately much too small, the deficiency of my own being mainly in respect of observing-huts and general packages.] Approval to a certain extent was given by the Admiralty, and instrumental and other preparations were begun. Those transactions were reported to the House of Commons on July 6.

The Board of Visitors of the Royal Observatory, at their meeting of 1871, June 3, passed the following resolution :—" After a discussion it was " resolved, that,—as the Board deem it most important that photographic- " be combined with eye-observations at the approaching Transit of Venus, " an opinion in which the Astronomer Royal fully concurs,—the Chairman " apply to the Lords Commissioners of Her Majesty's Treasury to sanction " a grant of five thousand pounds (5,000*l.*) for the purpose ; a sum which it is " considered will cover the cost of photographic apparatus and observations " for all the stations." The Board of Admiralty requested my opinion on this proposal, and in reply, though expressing myself guardedly on its success, I gave my opinion in favour of it.

Meantime the general plan of the proposed Expedition had become the subject of much public discussion ; and in particular, letters appeared in the " Spectator " of 1873, February 8, and the " Times " of February 13, strongly urging the adoption of Enderby Land (which after careful consideration I had rejected) for a southern station. The Board of Admiralty sent these papers for my opinion, and in my reply, dated February 21, after elaborate discussion of the question, I declined to recommend that adoption. At their Lordships' request, my reply was communicated to the Royal Astronomical Society, and it is printed in their *Monthly Notice* of 1873, March 14.

On 1873, March 22, a statement on the general plan was made to the House of Commons.

Preparations had now advanced for collecting an efficient body of observers from all classes, Naval, Military, and Civilian, and for their instruction at the Royal Observatory in all the practical details of observation with the Transit, the Altazimuth, the Equatoreal, and especially with the working model of the Transit. Among the candidates who early offered their services was Captain G. L. Tupman, R.M.A. I soon found that this gentleman might be trusted with a large portion of the superintendence of preparations and instructions, which, amid the engrossing business of the Royal Observatory, it was impossible for me to undertake completely. On 1873, March 21, I gave in an elaborate Report of preparations, and stated that valuable assistance had been received from Captain Tupman.

The Board of Visitors of the Royal Observatory, at their meeting of 1873, June 7, passed the following resolution :—" That in consideration of the fact " that the successful result of the entire scheme of observation of the

" approaching Transit of Venus will depend to a great extent on observations " being made in the Southern Hemisphere, to compare with those which are " already amply provided for in Siberia and China, it is in the opinion of " the Board of Visitors very desirable that parties suitably equipped be " despatched to the South, in the hope of finding some additional practicable " places at which the entire duration of the Transit may be observed." The Admiralty, in reply to the Board of Visitors, adverted to the voyage of the " Challenger," and to the prudence of waiting for reports from that ship. I may here state that subsequent information thus obtained justified the entire rejection of the Heard Islands, on account of the extreme uncertainty of communication (the Crozet Islands had been previously rejected for the same reason), and indicated unexpected facilities in the adoption of the southern part of Kerguelen Island.

On 1874, January 24, I placed before the Admiralty a general statement of arrangements, and on March 11, Captain Tupman was first put in communication with the Accountant-General, the Director of Transports, and the Hydrographer, for management of the expedition when afloat and of its money-affairs. On May 4, in reply to a letter of the Admiralty, I offered my strong testimony to the value of Captain Tupman's services.

The greater portion of the observing parties sailed in the early part of summer; that for Egypt naturally much later than the others. Time, however, was occupied by the Egyptian party at Greenwich in practice for the operations with the long submarine telegraph. The several parties returned at different times: the breaking up of their residences depending, for the most part, on the completion of operations for longitude. On those points information will be found in the several Parts of the following work.

Some advance had been made by each party in the orderly record and partial reduction of their observations. As soon as Captain Tupman returned, all the observers were placed under his superintendence, at the Royal Observatory, for completing their share of the reductions and for measure of the photographs. As the work of each observer was finished, he was discharged from the service. The last was Lieut. Neate, R.N., from Rodriguez; his return was late, and his calculations voluminous; and they were not finished before October 1876.

From this time every calculation was subjected to the severe examination of Captain Tupman.

On 1877, April 14, a member of the House of Commons gave notice to the First Lord of the Admiralty of his intention to inquire, on April 19, when

the Results of the Observations, &c. might be expected to be laid before Parliament. In consequence of this, every effort was made by Captain Tupman to accelerate partial reductions and to combine the results; and a Return was made to the House of Commons, dated 16th July 1877, and was ordered for printing on the same day. The substance of this Report, as regards observations, &c. is entirely included in the details of the present volume.

In the meantime the affairs of the Transit of Venus were in great difficulty. Captain Tupman, with scarcely any assistance, was occupied with the vast mass of reductions. The Government, probably remarking the excess of expenditure above estimate, refused to sanction his stipend beyond 1878, March 31. Captain Tupman then addressed to me the following letter:—

"1877, November 7.

"I cannot allow a mere pecuniary consideration to prevent me finishing off properly the work I have had so much to do with. The Lords of the Admiralty will allow me to remain under you as long as you please, although they cannot grant special salaries.

"Perhaps things will be nearly completed by the end of March 1878. I hope to see the work through the press, and all the books and stores left in first-rate order.

"G. L. TUPMAN."

This determination of Captain Tupman was repeated on 1878, March 16.

With the assistance of one computer (whose salary was paid by myself for a long time, but was ultimately reimbursed to me) Captain Tupman continued his work gratuitously, examining severely every step of the observers' computations, and more especially all that related to instrumental adjustments. Never, perhaps, was such an enormous mass of calculations so severely criticized, and, where necessary, repeated; but it lasted much longer than had been anticipated. The authority of the Government had been received for printing the results; and this, on the scale adopted by Captain Tupman, added greatly to his labour. However, in the autumn of 1880 Captain Tupman, then about to quit the country, presented me with the calculations and portions of introductions for each station, and with the printed sheets for the observation-districts of the Sandwich or Hawaiian Islands and Egypt. Though anticipating for myself a heavy addition to the labours of an office already sufficiently oppressive, I could but feel grateful to Captain Tupman for the disinterested zeal—I may call it heroic—with which he had laboured to bring the work to that point.

The observations and reductions, I found, had been printed in great detail, especially for the district of the Sandwich Islands. It was desirable that this should be done to some extent as a general specimen of the operations; but I now determined to print the remainder on the scale which I had intimated in an address to the Royal Astronomical Society, published in their *Monthly Notice* for 1875, March 12, "In the accounts of transits it is sufficient to "give description of instruments and methods, constants of adjustments, "and tables of clock-errors, and analogous abstracts of comparisons of "chronometers, &c. But it is necessary to give in the fullest detail "everything that bears upon the actual observation of contacts, or upon "the observer's impression at the time of making the observation, or upon "the micrometer-measures, or upon the photographs and the measures "of the photographs, &c.; with sufficient description of the instruments and "their adjustments at the time. Clock Time and Local Sidereal Time are to "be given for every observation."

The carrying out of this change, though in its main feature it is a very large diminution of the matter prepared for press, yet, as it consisted of sometimes extracting numbers, sometimes taking the means of numbers, always requiring numerous references to the originals and to the first calculations founded on them, has in reality employed much of my time. It has, indeed, occupied all the hours, not engaged on routine business, on which I could usually have reckoned for other matters of science.

In regard to the form in which the Results are to be presented to the reader, I have thought it best to leave the reduced observations in the state in which he will find them near the end of each Part. I have endeavoured to give the Equations in the shape which will admit of combination in the easiest way for the computer's further operations—(whether he may desire to use the Calculus of Probabilities for the whole, or to make any special selection of combinations)—when he shall have decided on the recorded phase of contact of limbs which he thinks best to adopt. The numerical value of the first term of each Equation (on which all depends) will be adapted to any time differing from that which I have used, by merely expressing numerically in seconds that difference of time, and substituting it for the symbol δt.

In regard to the photographs, of which I have given, in the Appendix to this work, a general account, with sufficient details on the instruments

employed for their treatment, I conceive it to be possible that some astronomer may yet think them worthy of rediscussion. The photographs themselves are carefully preserved at the Royal Observatory. I do not imagine that any important improvement can be made in their measures; but perhaps the number of photographs may be reduced by judicious rejection of those whose definition is doubtful. And the theory of instrumental distortion, to which I have alluded in the Appendix to this work, may be considered.

It was recognized in some of the photographs that the limb of Venus was much distorted by atmospheric action; a corresponding distortion might be expected in the Sun's limb. And it was believed by some of the measurers of the photographs that irregularities of the Sun's limb, amounting to two or three seconds, produced uncertainty in the measures of the photographs: if that irregularity be real, it might be expected also to produce error on the same scale in the optical observations of contact.

G. B. AIRY.

Royal Observatory, Greenwich,
1881, June 6.

George Davidson

TRANSIT OF VENUS, 1874.

Oct 12, 1882

Part I.

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EXPEDITION

TO THE

HAWAIIAN (SANDWICH) ISLANDS,

UNDER

CAPTAIN G. L. TUPMAN,

ROYAL MARINE ARTILLERY.

SECTION I.
OBSERVATIONS AT HONOLULU (OAHU).
With Five Plates.

SECTION II.
OBSERVATIONS AT KAILUA (HAWAII).
With One Plate.

SECTION III.
OBSERVATIONS AT WAIMEA (KAUAI).
With One Plate.

TRANSIT OF VENUS, 1874.

PART I.

EXPEDITION TO THE HAWAIIAN (SANDWICH) ISLANDS.

Section 1.

OBSERVATIONS AT HONOLULU (OAHU).

With Five Plates.

TRANSIT OF VENUS, 1874.

PART I.

EXPEDITION TO THE HAWAIIAN (SANDWICH) ISLANDS.

SECTION I.—HONOLULU.

VOYAGE, AND ESTABLISHMENT AT HONOLULU.

1. The Expedition destined for the Hawaiian Islands left England in two detachments on board the Pacific Steam Navigation Company's steamships *Illimani* and *Britannia*, starting from Liverpool 1874, June 3 and June 17 respectively, and proceeding by way of the Straits of Magellan to Valparaiso. At the latter port, H.M.S. *Scout*, Captain R. P. CATOR, R.N., by the orders of Vice-Admiral the Hon. Arthur Cochrane, C.B., was awaiting their arrival, and, having transhipped the baggage, she sailed on the 4th August with all the Expedition, and arrived at Honolulu September 9.

2. The time occupied by the long voyage was usefully employed in preparing auxiliary tables to facilitate the reduction of time and other observations on the spot. Thus the Apparent Right Ascensions of all the Greenwich Clock Stars not included in the Nautical Almanac Fundamental Catalogue for 1874 were computed for intervals of 10 days between the dates likely to be required.

3. An elaborate set of meteorological instruments having been lent to the Expedition from the Meteorological Office in London by the Director, R. H. SCOTT, Esq., an accurate journal was kept during the voyage, in which the state of the instruments, weather, &c. was recorded every four hours.*

4. On arrival at Honolulu the Expedition was most cordially welcomed by His Majesty King KALAKAUA, and by the Ministers of State. The Expedition was greatly indebted to His Excellency Mr. W. L. GREEN, Minister of Foreign Affairs, and to Major James Hay WODEHOUSE, Her Britannic Majesty's Commissioner, who, from first to last, exhibited great interest in and materially aided all the operations.

5. A good site was obtained without difficulty, through the active co-operation of Captain Daniel SMITH, the harbour master.

His Majesty the KING placed at the disposal of the Expedition, rent free, a suitable piece of open land in the southern extreme of the town. To enable the party to be lodged conveniently near their instruments, H.R.H. the

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* It may be stated here that the Meteorological Journal was continued during the stay of the Expedition at Honolulu, and has since been deposited at the Meteorological Office, Victoria Street, Westminster.

Princess RUTH, at the suggestion of Governor DOMINIS, of Oahu, considerately vacated her own house, known as HONUAKAHA HALE, and allowed it to be rented on liberal terms.

6. It is difficult to do justice to the exertions of Captain R. P. CATOR, R.N., of H.M.S. *Scout*, who remained at Honolulu until the middle of December, and of Commander VAN der MEULEN, R.N., of H.M.S. *Tenedos*, to whose careful forethought and continual personal superintendence the success of the Expedition was in no small degree due. After the tedious operations of transporting the chronometers backwards and forwards to the Islands of Hawaii and Kauai, the *Tenedos* was succeeded by H.M.S. *Reindeer*, Commander C. V. ANSON, by whose cordial co-operation the outlying parties were brought back to Honolulu, and the Expedition finally taken to San Francisco on its way home.

7. Mr. David FLITNER, of Honolulu, who himself successfully observed the Ingress of *Venus* at Waiakiki, most generously lent a number of marine chronometers to assist in the longitude operations. Captain D. SMITH also lent a chronometer for the same purpose.

8. I cannot close these remarks without recording the friendly welcome accorded to the members of the Expedition by the American and British communities of Honolulu. It would be invidious to mention a few names when all were so kind and hospitable that the reminiscences of our six months' sojourn on that far distant island will ever be of the most agreeable.

PERSONNEL.

9. The observing party at Honolulu consisted of Lieutenant F. E. RAMSDEN, R.N., who undertook the management of the Photographic Department, and also assisted in astronomical observations; Lieutenant (now Captain) E. J. W. NOBLE, R.M.A.; J. W. NICHOL, Esq.,* F.R.A.S., formerly assistant at the Royal Observatory, Edinburgh; and myself. In the following pages these observers are distinguished by the letters R., No., Ni., and T. respectively.

10. There were also attached to the Expedition Lance-Corporal CURRY and Sappers M. MEINS and J. MYERS, *Royal Engineers*, who rendered most effective assistance generally, and in the Photographic Department especially, and voluntarily kept the four-hourly Meteorological Register during our stay at Honolulu.

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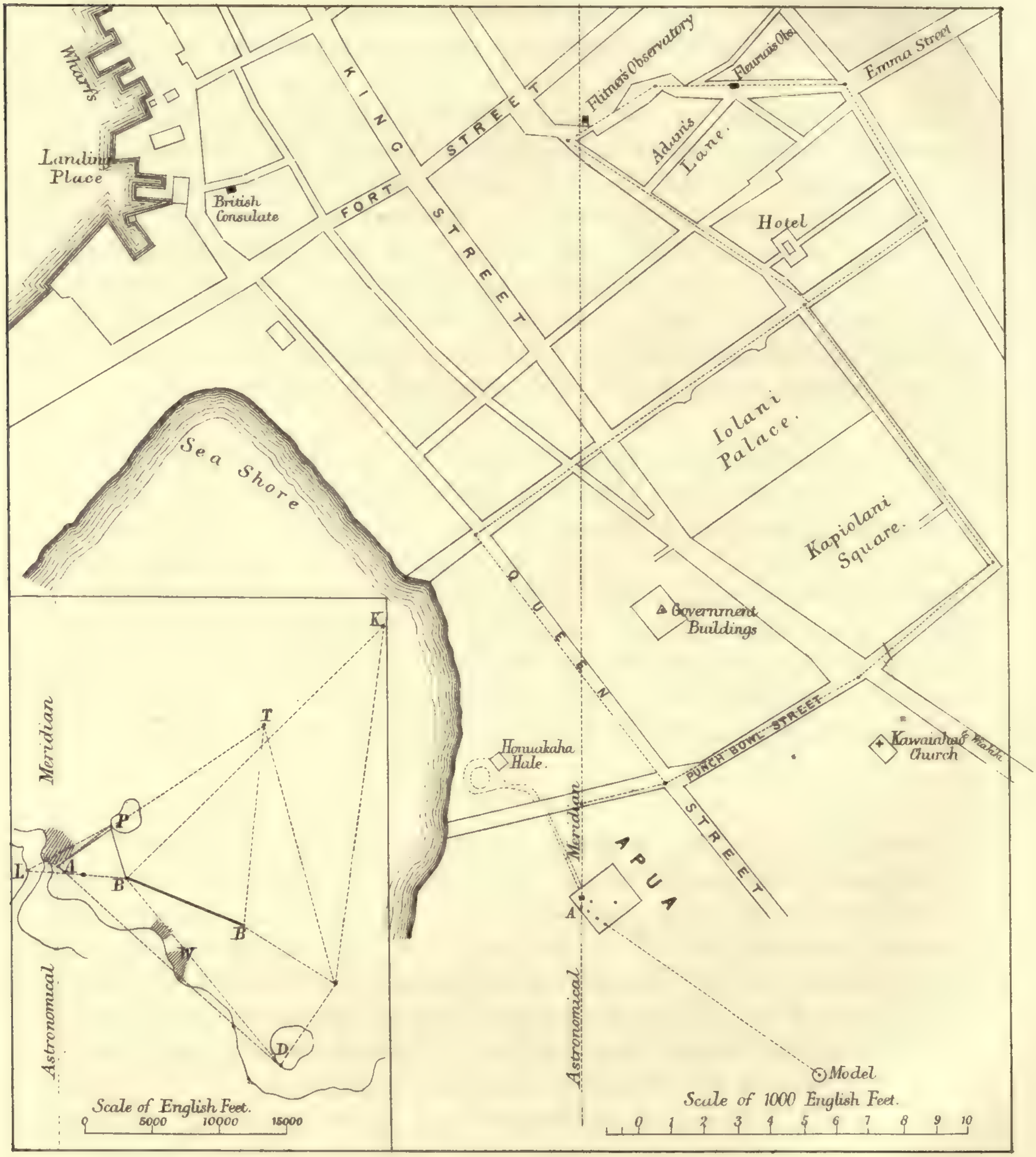
* Mr. Nichol died in November 1878.

Plan of a portion of Honolulu showing the position of the Transit of Venus Station. The smaller plan shows the position of the Station with regard to the principal points of the Government Trigonometrical Survey.



References. A. a point 14·75 feet South of the Centre of the Transit pier at Apua.
BB. Base line of the Government Trigonometrical Survey.
D. Trig. Station on Diamond Head (Leahi)
K. „ „ „ Mount Konahuanui
L. „ „ „ Light house
P. „ „ „ Punch-bowl
T. „ „ „ Mount Tantalus (Punshia)
W. Village of Waiakiki.

Dangerfield Lith 22 Bedford St Covent Garden

To face page 7.

THE SITE AT HONOLULU.—Plates I. and II.

11. The open piece of grass land in the district called Apua is situated south of Punchbowl Street and west of Queen Street. A portion, in every way suitable for our purpose, was enclosed with a wooden fence, and the instruments, &c. were there set up, as represented in Plate II. The actual site of the Transit Pier was 300 feet from the centre of Punchbowl Street, 420 feet from Queen Street, 910 feet from the flagstaff on the New Government Buildings, and 1,040 feet from the spire of Kawaiahao (stone) Church.

12. From a point 14·75 feet due *south* of the centre of the Transit Pier the following *true* bearings and distances were taken, to determine the relative positions of the instruments, and to connect the station with the Government Trigonometrical Survey:—

	° ′	
Spire of Kawaiahao Church................	N. 62. 0 E.	1,040± feet.
Trig. Survey Station on Punchbowl Hill.....	N. 49. 44 E.	5,104 „
„ „ „ Mount Tantalus.....	N. 55. 26 E.	
„ „ „ Diamond Head......	S. 46. 32 E.	
Center of Photoheliograph Pier	N. 76. 30 E.	28·5 feet.
„ Altazimuth Pier	S. 86. 57 E.	103·0 „
„ 4½-inch Equatorial	S. 59. 9 E.	35·0 „
„ 6-inch „	S. 52. 27 E.	70·0 „

13. In or about the year 1845 Professor LYMAN, now of Yale College, Connecticut, then residing in Honolulu for the benefit of his health, made a number of meridional observations of the Moon in order to determine the longitude. It is supposed that these observations have never been published, but their utility was such that in 1874 the Hawaiian Surveyor-General was still using the longitude communicated to him by Professor Lyman. The observatory and transit instrument of Professor Lyman passed into the hands of DAVID FLITNER, Esq., chronometer maker, of Honolulu, and in 1874 they were in perfect order. The position of the observatory is shown in Plate I.

14. In the year 1868 M. FLEURIAIS, deputed by the *Bureau des Longitudes* to determine the longitudes of various points in South America, established himself at Honolulu. With the friendly assistance of M. BAILLIEU, Commissioner for France, the actual site of M. Fleuriais' Observatory was recovered through some remains of the masonry of the Transit Pier which were found *in situ* on the coral rock, five feet below the surface of the road, by the

workman who had built and who had afterwards removed the brickwork.* It was situated on the north side of Emma Street, immediately opposite to the end of Adam's Lane.

15. At my request, Mr. J. N. GAY, surveyor, of Honolulu, kindly made the following traverse with a 5-inch theodolite and 66-foot chain, to connect the station at Apua with the observatories of MM. FLEURIAIS and FLITNER.

Theodolite Stations.	True Azimuth.	Distance in English Feet.	—
A to B †	North.	14·75	In the direction of the North Meridian Mark.
B to C	North.	295·5	
C to D	N. 76°. 40′. E.	261·	
D to E	N. 38°. 34′. W.	950·	D to Z, N. 0°. 37′. W.
E to F	N. 55°. 38′. E.	1251·5	E to Z, S. 68°. 32′. E.
F to G	N. 55°. 34′. W.	893·5	
G to H	N. 41°. 57′. E.	79·	
G to I	N. 60°. 41′. E.	320·	
I to K	N. 88°. 30′. E.	217·5	
K to L	N. 88°. 30′. E.	341·	
L to M	S. 30°. 41′. E.	498·	
M to N	S. 54°. 31′. W.	459·5	
N to O	S. 37°. 15′. E.	961·5	
O to P	S. 48°. 21′. E.	559·5	
P to D	Not observed.	648·	

A. Position of Mr. Gay's theodolite within the enclosure at Apua.

B. The center of the transit pier.

H. The center of Mr. Flitner's transit pier.

K. M. Fleuriais' transit pier (restored).

Z. The flagstaff on the Government Buildings.

16. From the above, M. Fleuriais' pier was 2,474 feet *north* and 456 feet *east*, and Mr. Flitner's pier was 2,370 feet *north* and 12½ feet *east* of the center of the transit pier at APUA (*see the section* Longitude of Honolulu).

17. A stage was erected near the southern angle of the enclosure to carry the telescopes used for observing the model. Water was laid on from the main in Punchbowl Street. There were two taps on which to attach hoses in case of fire (the fire buckets and tubs were always kept filled), and three other taps for photographic and other purposes. Corporal Currie, Sappers Meins and Myers, R.E., lived on the premises, and the observers' residence, Honuakaha Hale, was about 130 yards distant on the other side of Punchbowl Street.

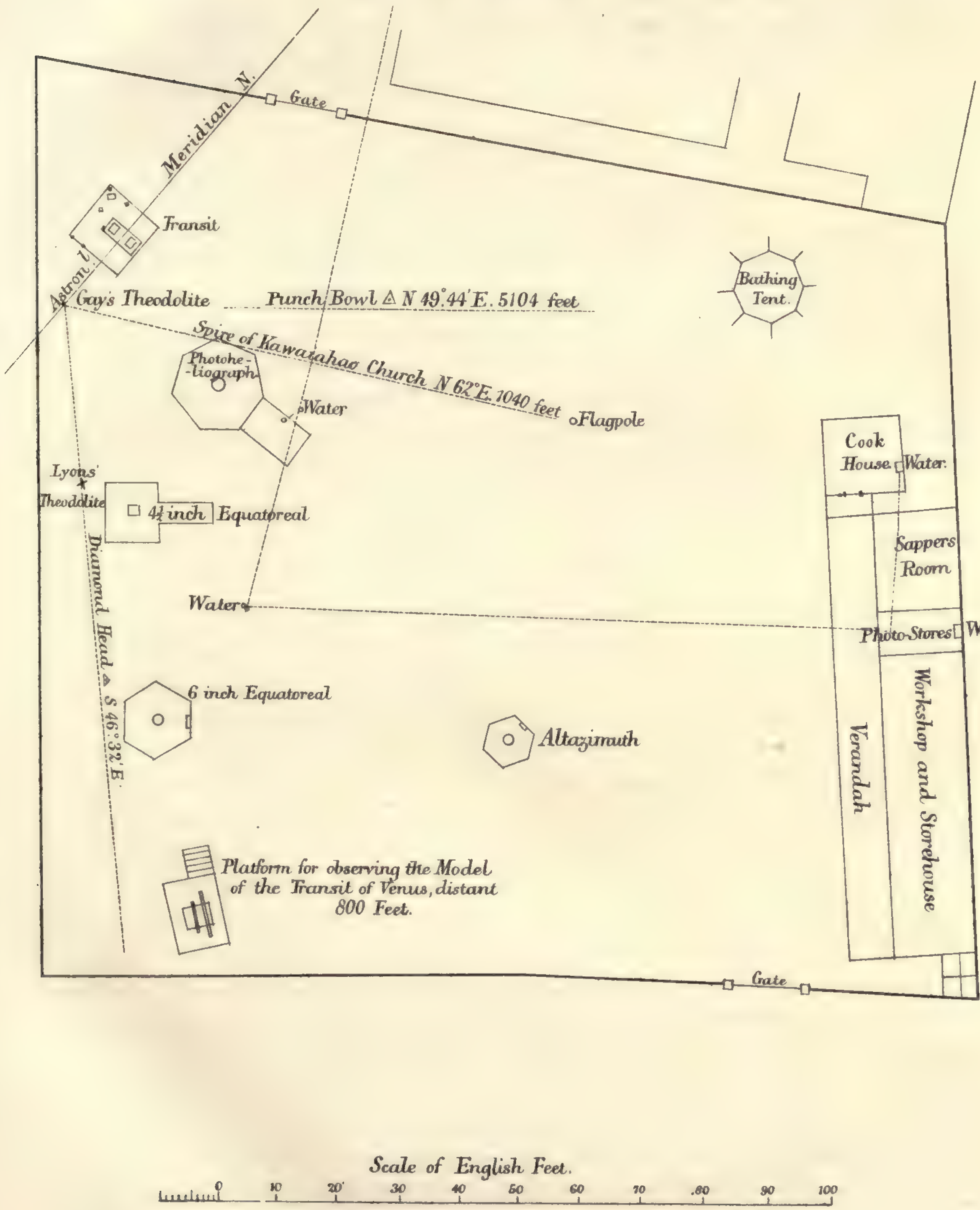
* To preserve this site I erected a small brick pier, the top of which was left about one foot below the surface of the road.

† The lines of the traverse are shown in Plate I. by a dotted line. The reader, following the Azimuths given above, will without difficulty identify the points B, C, D, &c.

Transit of Venus, 1874 December 8.

Plan of the Observing-Station at Apua, Honolulu.

Latitude of the Altazimuth Pier 21° 17′ 56″.9 North; Longitude 10h 20m 26s.3 West of Greenwich.



To face page 8.

Dangerfield Lith 22 Bedford St Covent Garden.

18. In this part of the town the coral is covered by some four feet of very light sandy soil. Although high-water mark was half a mile distant, the tide percolated through the coral and rose many inches above its surface, but in no way interfered with the stability of the piers, which were set with cement.

The Transit Clock.

19. This was constructed by Messrs. E. Dent and Co., of London, in 1870, and was numbered 1916. The compensation of the pendulum was effected by their well-known cylindrical combination of zinc and steel. The clock, in common with all the clocks employed on the Transit of Venus Expeditions, was tested for a long time at the Royal Observatory, Greenwich, under very trying variations of temperature, and its performance was excellent. At Honolulu it was mounted on a massive tripod of mahogany and iron, which rested upon three stakes driven 2 or 3 feet into the ground. It was wound every Sunday at noon. The suspension spring of the pendulum was changed, 1874, November 7, after which the rate was remarkably steady (Tab. V.).

The Transit Instrument.

20. Five transit instruments, precisely similar in all respects, were constructed for the Expeditions by Messrs. Troughton and Simms. One of these was used at Honolulu. The object glass was very nearly 3 inches clear aperture and $36\frac{1}{2}$ inches focal length. The axis, consisting of central cube and cones, was cast in one piece. Its length from shoulder to shoulder (that is, exclusive of the pivots,) was 18 inches; the pivots were $1\frac{1}{4}$ inches long and $1\frac{1}{2}$ inches diameter. The cube was of 6 inches side; the cones were $5\frac{1}{2}$ inches in diameter at the cube and $2\frac{1}{8}$ inches at the shoulder. The two tubes which, with the cube, formed the telescope, were $4\frac{1}{2}$ inches in diameter at their attachment (by flanges) with the cube. When the dew cap was on, the instrument weighed 44 lbs., and was perfectly balanced on its pivots.

21. The system of webs, consisting of 5 vertical webs, at intervals of about $3\frac{1}{2}'$, and two horizontal webs, about $5'$ apart, was mounted on the plate driven by the micrometer screw, so that the whole system moved when the screw was turned. The head of the micrometer screw was divided on silver to 100 parts, and was provided with a movable brass cover to prevent it being accidentally turned when not actually in use, as when observing time-stars. The thread of the screw was kept bearing in one direction by a spiral spring

within the box, as with all Messrs. Troughton and Simms' micrometers. There was no perceptible "loss of time" in any one of them. The eye-piece was moved rapidly from wire to wire by a quick screw, the milled head of which was opposite to the micrometer-screw-head. The illumination of the wires was effected in the usual way by lamp-light passing through one of the pivots on to a gilt reflector, regulated by a rod leading down to the eye-piece. There was a polar distance setting circle $4\frac{1}{2}$ inches diameter on each side of the tube near the eye end.

22. A solid pier of brick and cement, $6\frac{1}{2}$ feet by $3\frac{1}{2}$ feet at the top and somewhat larger at the bottom, was built up from the coral (previously levelled) to about the surface of the ground. On this was laid, levelled, oriented, and cemented a great stone, 6 feet by 3 feet and 6 inches thick, weighing 1,500 lbs. After the cement had well set, the stone piers were placed in position. These piers were 4 feet 11 inches high, 24 inches by 21 at the base, and 11 inches square at the top, and weighed nearly 1,400 lbs. each.* The Y's were of massive construction, one having an adjustment for azimuth the other for level. They were attached to the tops of the piers by heavy sockets cemented into the stone. The supporting faces of the Y's were inclined 90°, and were rounded so as to touch a very small surface of the pivots. When the instrument was thus mounted, a heavy blow with the fist administered to the top of one of the piers merely produced a momentary tremor of the optical image of a distant object.

23. The instrument was provided with three eye-pieces of powers 45, 75, and 120. The power of 75 was always used at Honolulu. A small prism of total reflection could be attached to the eye-piece for the more convenient observation of stars near the zenith. The shape of the piers left plenty of room for the observer to sit between them.

24. For determining the level-error, the instrument was fitted with a Bohnenberger eye-piece and mercury trough, and with a hanging level of delicate construction graduated with about 12 divisions to each inch, 46 of which were equivalent to one minute of arc. The divisions were numbered from 0 to 100, the readings increasing towards the cross-level. The glass bubble itself was protected by a covering of plate glass. The value of the graduations was re-determined by the makers just before the expedition started, several years after the instruments were made.

* Three great stones similar to these, forming the mounting of the transit instrument, and the wooden observatory, 13 feet square, were sent out from England with each expedition.

25. *The equatorial intervals of the wires* were determined from 500 transits of clock stars, and 32 transits of close circumpolar stars. No accident happened to the wires during the four months of observations. The wires were named a, b, c, d, e, the wire a being farthest from the micrometer-screw-head. The equatorial intervals finally adopted were—

$$\left.\begin{aligned} a &= +\ 28^{s}{\cdot}483 \\ b &= +\ 14{\cdot}413 \\ c &= \quad 0{\cdot}000 \\ d &= -\ 14{\cdot}384 \\ e &= -\ 28{\cdot}426 \end{aligned}\right\}\text{For micrometer east.}$$

Consequently, to reduce the mean of the five wires to the center wire, the correction, with micrometer east, is $+\frac{0^{s}{\cdot}0169}{\text{sin. N.P.D.}}$. For all stars within 30° of the equator this correction has been taken as $= +\ 0^{s}{\cdot}02$ (micrometer E.)

26. *The value of one revolution of the micrometer screw* was obtained from very numerous observations of close circumpolar stars, chiefly of *Polaris.* Altogether there were made 64 separate determinations at different parts of the screw, each obtained from at least five bisections, all tending to show that there was no sensible drunkenness or error periodical on one revolution. The adopted value is 56″·251.

The integer revolutions of the screw were read from a comb in the field of view by means of the center wire; they were numbered in the observation-book so that the 20th revolution ($20^{r}{\cdot}000$) occupied the optical center as nearly as possible, with *increasing* readings *towards* the head. Thus $22^{r}{\cdot}000$ signifies that the system of wires was moved two revolutions from its central position towards the micrometer-screw-head.

27. The *Error of Level* of the transit axis was generally determined, with the hanging spirit-level described above, once or twice with every batch of time stars and with every circumpolar star observed for azimuth error. The relative position of the pivots, both in level and in azimuth, was subject to a regular diurnal variation. During the night the east pivot sank from 2″ to 3″, and moved to the north about the same amount. The adjusting screws were touched on 1874, October 5, after which date the level-error remained small and steady. Several shocks of an earthquake on 1874, December 28, produced no sensible alteration in the position of the instrument.

28. The correction to the level-error, as found by spirit-level, for inequality of the diameters of the pivots, was found, by repeated reversions of the instrument, to be on—

1874, October	2,	+0″·042	with micrometer	*west.*
,,	15,	+0·047	,,	,,
November	20,	+0·085	,,	,,
,,		+0·052	,,	,,

The adopted correction for inequality of pivots is +0″·06 micrometer west. The observed level-errors are given in Table I. The level-error adopted in the reductions for a group of stars has always been the mean of the determinations, by the same observer, accompanying the group.

29. *The Error of Collimation* of the transit instrument. There is no doubt that, during the long outward voyage, the ring clamp, on which the rigidity of the connection between the system of wires and the body of the instrument depended, became slightly loose, and that this escaped detection until November 6. Two or three times, during the month of October, parts of the eye-end connected with the micrometer were removed under the impression that they caused the uncertainty in the position of the optic axis. On November 6 the ring clamp above mentioned was tightened, after which there was no further trouble.

30. At first the collimation-error was determined by observing a close circumpolar star with reversed positions of the transit-axis. A few minutes before the star came to the meridian, the observer removed the brass cover of the micrometer-screw-head, set the center wire to some quarter of a revolution, and allowed the star to transit the center wire. The micrometer was then turned a quarter of a revolution or other known quantity, and another transit of the center wire observed. Five or six such observations were taken before the star came to the meridian; the instrument was then reversed, and the star observed in transit over the center wire with the micrometer successively set to the same readings as before, but of course in reverse order. The level-errors for these two sets of observations should differ by twice the inequality of pivots; but generally the level-error was determined before and after, and applied as found.

31. On 1874, October 5, a stout post with a T cross head was set up on the north side of the transit-hut, to support a telescope of 30 inches focal length with cross webs in the focus of the object glass. The post was entirely protected from the direct rays of the sun by screens of rushes. The observations of this collimator were generally made at night. The transit instrument was always reversed twice because the collimator was not always perfectly steady. After November 4 the meridian mark was more generally

used. The mark (or the cross of the collimator) was bisected five or six times with the center wire. The observations of the meridian mark are given in Table III.

32. As the whole system of wires moved with the micrometer-screw, the error of collimation is always the difference between the actual reading of the micrometer and the reading which corresponds to zero, or when the center wire coincides with the optic axis. If M be the former, Z the latter, and R the value of one revolution, the collimation-error in arc is given with its proper sign for micrometer *east* by the formula—

$$+ (Z - M) R.$$

The readings for Z as determined by observation are shown in Table II. The adopted reading and M are given each day with the transits of stars.

33. *The Azimuth-Error* of the transit instrument was found in the usual way by combining observations of Polaris, δ Ursæ Minoris, Cephei (Hev.) 51, or λ Ursæ Minoris, with those of clock stars. Some difficulty was experienced in setting up a meridian mark at a proper distance. To the south the sea-shore was too near; to the north there was no choice; the crest of a range of hills four miles distant, and very difficult of access, was the only available place. On November 4 Mr. Nichol, accompanied by Mr. C. J. Lyons, of the Government Survey, who was well acquainted with the country, with a party of native workmen, ascended the mountain to the height of 1,540 feet, and erected the mark exactly on the crest of the hill, so that it showed out in bold relief against the sky at an altitude of 3° 40′. The mark itself consisted principally of two vertical posts of timber, 16 feet long and 4 inches by 3 in section, planted with 4½ feet of their length in a stiff red clay, and shored up with four stout stays. The clear space between the inner surfaces of the posts was 9·94 inches, and subtended 8″·05 as seen from the transit instrument; its center was afterwards found to be about 10 inches east of true north, and to be 21,218 feet from the transit instrument.

34. The mark was observed for azimuth-error, after sunset, and as early as possible every morning, the center wire being placed by estimation centrally between the two posts. These observations showed a nearly regular diurnal movement of the optic-axis in azimuth of about 3″, the telescope pointing more east in the morning than in the evening. It was never possible to observe the mark during the heat of the day. In order to determine the absolute azimuth of the mark and the law of the azimuthal change of position of the instrument, the mark was illuminated through a hole in the center,

4 feet from the ground, from sunset to sunrise on the nights of 1875, February 6, 7, 8, and 9, and its image bisected with the micrometer every half hour. The hanging level, which was left in position and reversed only occasionally, was read at the same time; while as many circumpolar stars as possible were observed.

The results of the four nights' observations showed that the direction of the optic axis moved steadily to the eastward (when the telescope was pointed to the north) from sunset until $11^h. 30^m$ mean time. It then remained steady until sunrise. The observations of the mark corrected for level-error, compared with the stars, give the following absolute azimuths of the center of the mark from the center of the transit instrument:—

1875, February	6,	δ Ursæ Minoris	″ 9·66 east of north.
		Cephei 51	7·85
,,	7,	δ Ursæ Minoris	6·95
		Cephei 51	8·13
		λ Ursæ Minoris	7·88
		Polaris S.P.	7·11
,,	8,	δ Ursæ Minoris	9·20
		λ Ursæ Minoris	8·53
		Polaris S.P.	7·67
,,	9,	δ Ursæ Minoris	8·10
		Cephei 51	8·85
		λ Ursæ Minoris	9·44
		Polaris S.P.	8·88

The adopted absolute azimuth is 8″·32.

35. On 19 mornings there are observations of Polar Stars not very long before the mark was observed. Assuming that the instrument was steady in azimuth after midnight, each of these gives a determination of the absolute azimuth of the mark. The mean of them is 8″·23.

36. The azimuth-error adopted in the reductions for a group of stars has been found in the following manner:—If the middle time of the group is later than $11^h. 30^m$ mean time, a mean has been taken of the azimuth-errors found from circumpolar stars and the morning observation of the meridian mark. For example, on 1874, November 22, Table III., there are four determinations of the Error of Azimuth after midnight (three by circumpolar stars, one by the meridian-mark), the mean of which has been used in reducing the group of clock stars observed after midnight. When the middle time of the group falls before $11^h. 30^m$ mean time, it has been assumed that the change of azimuth, denoted by the difference between the

evening and morning observations of the mark, took place with uniformity between the evening reading and $11^h. 30^m$ mean time. If the mark has not been observed in the morning, the mean change $2''\cdot5$ has been used, and a proportional part applied to the evening observation of the mark. This azimuth-error has then been combined with those obtained from circumpolar stars. For example, on November 13, Table III., the difference of azimuth by the evening and morning readings of the mark is $3''\cdot37$. Clock stars were observed at about 10^h, that is, four hours after the observation of the mark. It is assumed that a change of $2''\cdot45$ took place in those four hours, and that, therefore, the azimuth-error by the mark was $-0''\cdot92$. The error used for the group is the mean between this and $-0''\cdot72$ found by Polaris at $9^h. 40^m$.

Table III. contains the whole of the determinations of azimuth-error and the observations of the meridian mark.

TRANSITS OF STARS AND OF THE MOON OBSERVED AT HONOLULU, AND DEDUCED ERROR OF THE TRANSIT-CLOCK DENT 1916.

37. The stars observed for clock-error were taken from the catalogue of clock stars in use at the Royal Observatory, Greenwich. The Mean Right Ascensions were brought up to the beginning of the year from the Greenwich Catalogue of 2760 Stars, Epoch 1864, and are identical with those adopted at the Royal Observatory. For those stars found in the Nautical Almanac the apparent places have been taken from that work, a small constant correction being applied to reduce them to the standard of the 1864 Catalogue. The Moon Culminating Stars, for which good places have not been recently obtained, have been rejected. The Apparent Right Ascensions of such stars of the Greenwich list as were not in the Nautical Almanac were brought up, during the outward voyage, for every ten days of the period during which they were likely to be required.

38. In reducing the observed transits of clock stars the mean of the five wires has been, for convenience, reduced to the center wire by the correction $0^s\cdot02$, additive when the micrometer was east. The diurnal aberration has been taken as follows:—

	s
For Polaris	0·80
,, δ Ursæ Minoris	0·32
,, Cephei 51	0·40
,, λ Ursæ Minoris	1·03
,, all the Clock Stars...........	0·02

These quantities have been applied to the Apparent Right Ascensions throughout.

39. For the convenient application of the corrections for level, collimation, and azimuth, a table of factors was computed for every degree of N.P.D., similar to that contained in the Introduction to the Greenwich Observations. Similar factors were computed for the four azimuth-stars for every 15 days. For the more accurate reduction of circumpolar stars observed rather far from the meridian, and of imperfect transits of clock stars, the collimation factors were computed to four places of decimals. The observations of circumpolar stars more than eight minutes of time from the meridian have been reduced by the rigorous formula.

40. The clock-correction was required for (1) the transit of the Moon; (2) the Altazimuth observation of the Moon; (3) the comparisons of travelling chronometers; and (4) for latitude observations. No night was allowed to pass without the clock and instrumental errors being determined, if possible; and a sufficient number of observations were made to obtain the relative personal equations of the observers; which was necessary, because the observation of the Moon with the Altazimuth was too fatiguing to admit of many stars being taken by the same observer.

41. The observed Transits of the Moon and Stars, as arranged in Table IV., require little explanation. The day commences at noon, $10^{h}. 31^{m}$ later than noon at Greenwich. The reading and position of the micrometer are given (in the third column) for every star, it being understood that a given reading is to be carried down the column until a change occurs. In this column the adopted reading for zero of collimation for the day is also given in a bracket, thus [20·070]. It generally applies to all the observations made in one night, but occasionally different values have been used for different observers. When a circumpolar star has been observed with reversed positions of the transit-axis, the two observations are separately reduced. The clock correction proper to apply to the true transit of the Moon's limb is entered in the eighth column in a bracket, thus [20·86], on October 17, Table IV.

42. It has been considered sufficient to print in detail the transits of the stars observed with the Moon, and those observed for azimuth-error on the days when the Moon was observed with the Altazimuth. All other transits are omitted. Each observer's mean result for clock error is given in Table V.

43. *Determination of the relative personal equation in observing transits of stars of the observers at Honolulu.*

In the following table $T - R = +0^{s}\cdot22$ signifies that T makes the clock $0^{s}\cdot22$ more slow than does R. The numbers are obtained from Table V. by interpolation.

T — No		T — R		No — R	
	s		s		s
1874, Oct. 9	— ·14	1874, Oct. 8	+ ·08	1874, Oct. 9	+ ·32
21	— ·15	9	+ ·18	20	— ·07
22	+ ·16	17	+ ·10	22	+ ·10
Nov. 13	+ ·08	22	+ ·26	24	+ ·09
23	+ ·08	Nov. 8	+ ·12	25	— ·14
27	+ ·07	12	+ ·26	26	+ ·07
28	— ·01	16	+ ·11	27	+ ·13
Dec. 1	— ·05	23	+ ·17	Nov. 9	+ ·19
3	— ·06	27	+ ·14	14	+ ·10
8	— ·04	28	+ ·34	15	+ ·24
29	+ ·03	29	+ ·22	23	+ ·09
1875, Jan. 1	+ ·05	Dec. 13	+ ·26	27	+ ·07
26	+ ·04	1875, Jan. 2	+ ·32	28	+ ·35
28	+ ·02	4	+ ·16	30	+ ·19
30	+ ·04	6	+ ·20	Dec. 4	— ·02
		8	+ ·19	5	+ ·20
		9	+ ·14	7	+ ·20
		10	+ ·24	9	+ ·20
		11	+ ·22	10	+ ·31
		13	+ ·15	11	+ ·18
		27	+ ·29	15	+ ·09
		29	+ ·20	16	— ·06
				17	+ ·10
				29	+ ·38
				30	+ ·21
				1875, Jan. 23	+ ·06

The adopted personal equations are—

Until 1874, December 17, inclusive,—

$$\begin{aligned} & \quad\ \ ^{s} \\ T &= \ \ \cdot 00 \\ No &= \ \ \cdot 00 \\ R &= +\cdot 16 \end{aligned}$$

After December 17,—

$$\begin{aligned} T &= \ \ \cdot 00 \\ No &= +\cdot 04 \\ R &= +\cdot 22 \end{aligned}$$

44. The *Adopted Errors and Rates of the Transit Clock* are shown in Table V. The mean of each observer's group (omitting, of course, the circumpolar stars) is taken and corrected for personal equation, and the mean for the night is then found. The loss in 24 hours corresponds to the middle time between the times for which the error is adopted. The adopted rate corresponds to the time for which the error is adopted. This adopted rate has only been used during the six hours preceding and following the time to which it corresponds. At other times the "loss in 24 hours" has been used

as the rate. The clock-error proper to apply to the transit of the Moon's limb is explained on page 23.

THE ALTAZIMUTH INSTRUMENT AND OBSERVATIONS OF ZENITH DISTANCE.

45. Three instruments for zenith distance, rotating round vertical axes (frequently called Altazimuths, though possessing no accurate graduation in azimuth,) precisely alike in every particular, were constructed for the expeditions to Honolulu, Mokattam, and Rodriguez, by Messrs. Troughton and Simms. Each of these instruments had two vertical circles attached to the horizontal axis which carried the telescope. They were 14 inches in diameter, and were divided on silver to 5′ spaces. One circle was read by four micrometer-microscopes, supported by radial arms cast in one with the rotating body of the instrument. One revolution of each micrometer-screw was intended to be 60″. The movable micrometer frames carried two parallel wires of spider's web instead of the usual cross. The probable error of bisecting a division of the circle with one microscope was something under 1″. The other circle was read by the pointer on the other side of the instrument, where also was the illuminating lamp. Two zenith-distance levels, each divided approximately to 2″, were attached to the arms which carried the microscopes. The value of the divisions engraved on the levels were re-determined by the makers just before the Expeditions started.

46. The horizontal axis, telescope, and circles, were built together like a transit-circle. The object-glass had a clear aperture of 2·00 inches and focal length of 20 inches. The reticule consisted of five horizontal and six vertical webs, but the latter were only employed to define the middle points of the horizontal webs. The eye-piece used for all observations was a four-glass diagonal, power 33. The pivots were three-quarters of an inch in diameter, and were both pierced. The circles were interchangeable, and could be turned on their axes; but their positions were not altered during these observations.

Circles of plate glass, parallel to and concentric with the graduated circles, were placed outside the framework to protect the levels from the heat of the observer's body and reading-lamp. The illuminating-lamp was on the side opposite to the microscopes. The horizontal circle (which was only used for setting in azimuth) was 12 inches in diameter, and was read by two verniers. There were clamps in zenith-distance and azimuth, the former with a fine slow-motion screw, the latter with a rather quick screw, which was turned during a vertical transit to keep the object at the middle part of the

horizontal wires. For adjusting the verticality of the principal axis, two sensitive levels were attached to the lower portion of the revolving body. A sensitive striding level could be applied to the telescope axis, and the instrument could be used as a portable transit by clamping it on both sides in the meridian. The solid tripod base of the instrument stood upon three brasses let into a thick slab of slate, which formed the head of the pier. Each instrument was protected by a wooden hexagonal hut about eight feet in diameter, with a revolving roof, slit, and shutter, and was accompanied by a secondary sidereal clock with wooden pendulum rod, which was intended to be compared with the transit-clock, before and after every observation, by the intervention of a mean time half-seconds chronometer. A mercurial barometer, an aneroid, and thermometers, were also supplied. At Honolulu the instrument was supported by a solid pier of brick and concrete founded on the coral.

47. The observer first opened the hut as much as possible to let the instrument take up the temperature of the external air. He then compared a mean-time half-seconds chronometer with the Transit-clock and Altazimuth-clock by coincidence of beats, and recorded the barometer and external thermometer. When the observations were concluded, the clocks were again compared, this time commencing with the Altazimuth-clock; and the barometer and thermometer again recorded.

48. When observing a vertical transit, the zenith-distance levels were read before and after the transit, and the microscopes were read last. For a latitude observation, in which the instrument is not, of course, moved in azimuth, the levels were read immediately after the bisection.

49. For determining the zenith-point and intervals of the horizontal wires independently of the stars, collimating arrangements, similar to that described with the transit instrument, were set up on the south and east sides, and the same reversed telescope was used. This collimator was perfectly steady in zenith distance, and by its means the intervals of the horizontal wires from their mean were accurately obtained as follows:—

Day.	Observer.	Wire A.	Wire B.	Wire C.	Wire D.	Wire E.
1874, Oct. 10	NI	+ 6′ 3″·28	+ 3′ 6″·93	+ 0′ 4″·43	− 3′ 4″·67	− 6′ 9″·97
,, Oct. 11	NI	4·40	5·80	3·10	3·50	9·80
,, Dec. 18	NI	5·22	7·32	4·12	6·38	10·28
1875, Jan. 30	NI	3·94	6·44	3·54	4·86	9·06
,, Jan. 31	T	4·82	7·22	3·62	4·88	10·78
Mean adopted ..	..	+ 6. 4·33	+ 3. 6·74	+ 0. 3·76	− 3. 4·86	− 6. 9·98

The distance of the wire C from the mean of the wires was also found, from the times of 90 vertical transits, to be ·00479 of the interval from A to E. Taking this interval at 734″·3, C is distant 3″·52 from the mean. The value 3″·76 has been adopted, and for convenience has been applied to the zenith point, which is always greater by this amount for transits over all the wires than for observations with the center wire only.

50. The mean corrections for the runs of the four micrometers for 100″ were obtained as follows:—

Day.	Observer.	Correction for Runs for 100″.	No. of Determinations.
		″	
1874, Sept. 30	NI	— 0·22	4
Oct. 6	NI	— 0·23	4
,, 8	T	— 0·21	2
,, 13	NI	— 0·08	4
,, 19	NI	— 0·23	4
Nov. 12	NI	— 0·21	4
Dec. 3	NI	— 0·24	4
1875, Feb. 1	NI	— 0·29	4
,, 5	T	— 0·35	4
,, 5	T	— 0·23	4

The mean —0″·21 has been adopted throughout.

51. The Altazimuth pier was 103 feet east of the Transit pier, corresponding to a difference of time of $0^s·074$. This correction should have been applied to the Altazimuth clock-error, but it was overlooked until the reductions had proceeded so far that it was more convenient afterwards to apply the necessary correction to the longitude (*see* page 27).

52. The Errors and Hourly Rates of the Altazimuth Clock used in reducing the zenith-distance observations are shown in Table VI. All the comparisons of the solar half-seconds chronometer with the two clocks were made at the instant when the beats coincided. The clock was made by E. Dent and Co.; the pendulum rod was of wood. It was compared with the Transit Clock before and after every set of observations with the Altazimuth.

THE LATITUDE OF THE ALTAZIMUTH PIER.

53. The latitude was determined with great care, with the object of serving as a point of reference for the Trigonometrical Survey of the kingdom of HAWAII undertaken by the Government of His Majesty King KALAKAUA, and

which, under the able management of Professor W. D. ALEXANDER, had already made great progress when the Expedition visited the Islands. The stars selected were such as had been well observed in N.P.D. either at Greenwich, the Cape of Good Hope, Melbourne, or Oxford, and were equally distributed north and south of the zenith of Honolulu. Table VII. contains the adopted places of the stars and the separate determinations of N.P.D. that have been used. For stars south of the Equator a preference has been given to the N. P. D.'s determined at the Cape Observatory and at Melbourne.

54. The observations for co-latitude are shown in the Table VIII. The *fourth* column contains the time by the Altazimuth Clock, when the observer bisected the star with the middle part of the center horizontal wire, by turning the fine zenith-distance slow-motion screw. The error and rate of the clock have been given (Table VI.). The *fifth* column shows the position of the instrument, by the illuminating-lamp being on the observer's right or left hand as he faced the star. The *sixth* column contains the concluded circle-reading as obtained from the mean of the four microscopes corrected for runs. The *seventh* column contains the level indication, which is one half of the sum of four readings corresponding to the ends of the bubbles; for each level had 30 divisions to the minute.

The refraction in the *eighth* column has been computed from the Tables of Bessel's Refractions in the Appendix to the Greenwich Observations, 1853, and then multiplied by the factor 0·9947. [Mr. Stone, *Monthly Notices of the* Royal Astronomical Society, 1867, November 8].

55. The Mercurial Barometer, A_2 Casella No. 352, and External Thermometer were tested at the Royal Observatory, Greenwich, and were found to have no sensible errors. The former was suspended under the thatched covering of the East Collimator, where the temperature at night, as indicated by the attached thermometer, was always from 1° to 2° higher than the external air. The latter was attached to the north side of the Altazimuth hut, about four feet from the ground. The readings are given in the *ninth* column.

56. The observed zenith point in the *tenth* column is thus found: if C_l, C_r be the circle-readings for the same object, corrected for level and refraction, with the lamp left and lamp right respectively, and r_1, r_2 the corresponding reductions to the meridian, the zenith point is $\frac{1}{2}(C_l - r_1 + C_r + r_2)$.

The concluded zenith distance in the *twelfth* column is the difference

between the circle-reading corrected for level and refraction and the adopted zenith point.

The remaining columns require no explanation.

57. *Summary of co-latitudes.*

Zenith Distance.	North Stars.		South Stars.		Mean of North and South.
	Co-latitude.	Number of Stars.	Co-latitude.	Number of Stars.	
° ° 15 to 60	° ′ ″ 68. 42. 3·83	19	° ′ ″ 68. 42. 3·26	27	° ′ ″ 68. 42. 3·54
60 to 70	68. 42. 2·87	28	68. 42. 2·81	7	68. 42. 2·84
70 to 81	68. 42. 2·29	10	68. 42. 3·24	19	68. 42. 2·77
Means -	68. 42. 3·09	57	68. 42. 3·20	53	68. 42. 3·14

As was to be expected with so small an instrument, the flexure is insensible. It is to be remarked that the lines of sight of the low northern stars passed pretty closely over the summits of the mountains. The latitude derived from these stars differs 0″·8 from the general mean. The adopted latitude of the altazimuth pier is 21°. 17′. 56″·9 N. It is probable that the meridional deviation of the plumb-line from the vertical is considerable, as the sea is deep to the southward, and the axis of the mountain range only 4 or 5 miles to the northward.

ON THE LONGITUDE OF THE STATION AT APUA.

(1.) *Longitude of Honolulu Station from the Observations of the Moon on the Meridian.*

58. In Table IV. are given the observed transits of the Moon over the center wire as obtained from the mean of all the wires observed. When all five wires have been observed, the observation has been treated as if it were of a star, the sum of the instrumental corrections always being a fraction of a second. For the incomplete transits, of which there are five, the reduction of each side wire to the center wire has been obtained by multiplying the Equatorial interval by the factor—

$$\frac{(1 + m) \cdot \sin z.}{\operatorname{Sin} d \cdot \sin z^1.}$$

where m is the increase (in seconds of time) of the Moon's R.A. for the transit over a meridian distant 1^s of terrestrial longitude, as given in the section *Moon-culminating Stars* in the Nautical Almanac; z is the Moon's

geocentric zenith distance ; z^1 the apparent zenith distance ; and d the geocentric N.P.D.

59. The arrangement of the observations in Table X., and the values of the longitude derived from them, require but little explanation. The observed R.A. of the Moon's bright limb has been corrected for diurnal aberration, and the Tabular R.A. has been interpolated with fourth differences from the section *Moon-culminating Stars* in the Nautical Almanac, on the two assumptions that the longitude was $10^h. 31^m. 0^s.$ and $10^h. 32^m. 0^s.$ west of Greenwich. The adopted correction to the Tabular R.A. is taken from the *Appendix*, and depends upon all the observations made at Greenwich, Washington, Paris, Konigsberg, Strasburg, Oxford, and the Cape of Good Hope. These corrections are generally reliable to the extent of $0^s \cdot 05$, but occasionally, as at the end of the 1874 October lunation, and at the end of the 1875 January lunation, they are doubtful to the extent of $0^s \cdot 1$ or even more.

60. The clock-correction, proper to apply to the transit of the Moon to obtain the apparent Right Ascension of the limb, has been given with the observed transit, Table IV. When a sensible difference occurs between the clock-correction obtained from stars near the Moon in declination and that obtained from the other stars of the same group, the former has been adopted, if the Right Ascensions are sufficiently well determined.

61. The weights assigned are proportional to the square of the change of Right Ascension in 1^s. Half weight has been given to the observations on October 20, October 24, October 27, January 17, for reasons contained in the Notes.

62. The longitude of the transit pier is obtained as follows :—

Observer.	☽ I.	Number of Obs.	☽ II.	Number of Obs.	Mean.
	s		s		h m s
Noble	24·9	7	23·3	5	10. 31. 24·1
Ramsden	28·0	10	26·5	6	10. 31. 27·2
Tupman	25·7	8	27·7	16	10. 31. 26·7
			Mean................		10. 31. 26·0

These results are, however, not entirely free from systematic error, proceeding from the circumstance that the observations at Honolulu were made by eye-and-ear, whereas the observations at the fixed observatories, from which the errors of the tables are deduced, were made generally by the chronographic method.

(2.) *Longitude of Honolulu Station from the observed Zenith Distances of the Moon's Upper and Lower Limbs. Tables IX. and XI.*

63. Honolulu is very favourably situated for determining the longitude in this manner in the winter months, as the observations can be secured when the Moon's orbital motion is more or less perpendicular to the horizon, a condition, it is hardly necessary to remark, which was always observed. The observations were taken by Mr. Nichol and myself, fundamental time being taken from the transit-clock. Six or eight vertical transits of the Moon's limb, and two of a well-known star pretty near the Moon, constituted a complete observation; the instrument being, of course, used in reversed positions. The observations of the Moon are, on the average, rendered differential by means of those of the stars, and thus any error that might creep in from the error of the transit-clock having been determined by different persons is eliminated from the mean.

64. The observations of the stars were first reduced in the following manner:—The observed clock-time of vertical transit of the mean wire was reduced to local sidereal time by the application of the clock corrections in Table VI. This was the sidereal time at the transit pier and not at the altazimuth pier, as it should have been. With this slightly incorrect sidereal time, and adopted co-latitude 68°. 42'. 3''·1, was computed the star's tabular zenith distance given in the *seventeenth* column of Table IX., using the fundamental place of the star in Table VII.

The correction due to the difference of time ($0^s{\cdot}074$) between the transit and altazimuth piers was then applied, and the true tabular zenith distance obtained. This was compared with the observed zenith distance with the following results, for the excess of the tabular quantity when the star is east, the reverse when the star is west:—

EXCESS of the TABULAR ZENITH DISTANCES of STARS over the observed ZENITH DISTANCES, with changed sign for STARS WEST of the MERIDIAN.

Observer, Nichol.		Observer, Tupman.	
	''		''
1874, Oct. 5, α Leonis	+ 4·3	1874, Oct. 3, γ Leonis	+ 4·0
19, Fomalhaut	+ 3·3	7, α Leonis	− 1·3
24, Procyon	− 0·3	15, σ Sagittarii	− 3·0
27, α Aurigæ	+ 1·5	23, β Andromedæ...	− 1·2
28, Procyon	+ 2·8	25, α Tauri	− 0·8

Observer, Nichol.

			″
1874, Oct.	29, Procyon	−	0·3
Nov.	15, δ Capricorni	−	3·1
	16, Fomalhaut	+	1·4
	22, α Arietis	+	0·3
	23, α Tauri		0·0
	27, γ Leonis	−	0·8
	28, β Ursæ	−	1·0
	29, α Leonis	−	3·0
	29, α Leonis	−	2·2
Dec.	14, β Ceti	+	0·7
	15, β Ceti	+	0·7
	18, α Arietis	−	0·6
	19, α Tauri	+	0·4
	21, γ Geminorum ..	−	1·3
	26, δ Leonis	−	1·8
	30, α Virginis	−	0·5
	31, α^2 Libræ	+	1·8
1875, Jan.	1, α^2 Libræ	−	0·8
	13, β Arietis	−	0·9
	14, β Arietis	−	3·2
	16, α Tauri	+	1·3
	18, γ Geminorum ..	−	2·9
	19, β Geminorum ..	+	3·1
	19, β Geminorum...	+	1·4
	19, β Geminorum...	−	1·1
	23, δ Leonis	−	1·0
	24, β Leonis	−	2·5
	25, α Virginis	−	0·3
	27, α Virginis......	+	3·2
	27, α Virginis	−	2·0

Observer, Tupman.

			″
1874, Oct.	26, α Tauri	+	2·0
	26, α Tauri........		0·0
	26, Procyon	+	0·4
1875, Jan.	20, β Geminorum...	+	0·5
	20, β Geminorum ..	+	0·3
	20, β Geminorum...	+	1·0
	21, α Leonis	+	0·3
	21, α Leonis	−	0·1
	22, β Leonis	−	2·3
	22, β Leonis	−	3·3

The means of the above numbers are, for Mr. Nichol − 0″·10
for Capt. Tupman − 0·23

These quantities show that a very small systematic error is introduced by using the time found by the transit instrument.

65. The whole of the vertical transits of the Moon and of stars are given in Table IX.

Column 4 is the mean of the clock times of transit over the five horizontal wires. No imperfect transits were observed. No correction is ever required for inequality of motion in z. d. The local sidereal time of observation (subject to a small constant correction of $+0^{s}{\cdot}07$) is obtained by applying to the time in column 4 the proper clock correction taken from Table VI.

Column 6 contains the reading of the vertical circle, as obtained always from the mean of the four microscope-micrometers corrected for runs.

Column 7 is the level indication, always additive, and is the sum of the four level readings divided by 2, the divisions on the levels being of the value of 2″.

Column 8 contains the readings of the mercurial barometer suspended in

shade in the open air, close to the altazimuth hut. The temperature of the column of mercury was therefore sensibly the same as that of the external air as indicated by the verified thermometer suspended on the north side of the altazimuth observatory, the readings of which are inserted in the same column.

Column 9 contains the refraction computed as described on page 21. It is additive to the circle-reading when the lamp is "left."

Column 10 contains the true observed zenith distance obtained by applying the zenith point given at the bottom of the page to the circle-reading connected for level and refraction.

Column 11 contains the *Greenwich Mean Solar Time* corresponding to the (slightly inaccurate) local sidereal time of observation on two assumptions of the longitude, viz., $10^h. 31^m. 0^s$ and $10^h. 32^m. 0^s$ West of Greenwich.

The *Tabular Geocentric Right Ascension* and *North Polar Distance* of the Moon's center, given in the *twelfth* and *thirteenth* columns, have been interpolated with second differences from the hourly ephemeris in the *Nautical Almanac*, and have been corrected for errors of the tables by the quantities given in the Appendix. The corrections applied are not absolutely identical with those used for the Moon culminations, but the difference is unimportant, as explained in the Appendix.

The *Moon's Equatorial Horizontal Parallax* and *Semidiameter* have been interpolated from the 12-hourly ephemeris.

The *Tabular Zenith Distance* in the *seventeenth* column has been computed by the normal-centric method, from the formulæ given at length in the introduction to recent volumes of the *Greenwich Observations* (Section Altazimuth Observations). The *hour angle* is shown in the *sixteenth* column.

The *eighteenth* column contains the longitude as inferred from a comparison of the two *tabular* zenith distances of the limb of the Moon with the *observed* zenith distance in column 10. This longitude is subject to future correction, in consequence of the original error in the local sidereal time as explained above. The difference between the two tabular zenith distances corresponding to the local sidereal time of observation affords the measure of the value of the observation.

66. Table XI. contains the Altazimuth results for each day. Each result is corrected, and all are combined with the assigned weights to form the mean.

The correction in the *fifth* column is on account of the difference of longitude between the transit and altazimuth piers, which was neglected in forming the table of corrections of the altazimuth clock. It is thus computed:—

The vertical interval between the first and last wires is 734″·3; if t be the interval in seconds of time required by the Moon's limb to pass over this space during vertical transit, and $z_1 \sim z_2$ be the difference between the two tabular zenith distances corresponding to the two assumptions of longitude, the correction to the longitude always positive in seconds of time is found from the expression—

$$\frac{734 \cdot 3 \times 0^{s} \cdot 074 \times 60}{t \times (z_1 \sim z_2)}$$

The mean value of t and $z_1 \sim z_2$ for the day has been used.

The weights in the *seventh* column are approximately proportional to the square of the quantity $z_1 - z_2$. When the zenith distance of the Moon at the time of observation is near 80°, and also when the corrections to the tabular place of the Moon have been unsatisfactorily determined, only half weight has been allowed. The observations on three days have been rejected, there being no data for correcting the tables.

The resulting longitudes of the Altazimuth pier are:—

	☽ I.	No. of Days Obs.	☽ II.	No. of Days Obs.	Mean.
	s		s		h m s
Nichol	25·7	22	29·8	24	10. 31. 27·7
Tupman	25·3	7	28·5	7	10. 31. 26·9
				Mean..........	10. 31. 27·3

(3.) *Longitude of Honolulu from Occultations of Stars by the Moon.*

For the reduction of the observed occultations, the corrections to the Tabular Geocentric R.A. and N.P.D. of the Moon's center have been taken as follows:—

	Correction to R.A.	Correction to N.P.D.
	s	″
1874, Oct. 14	− 0·30	− 2·2
,, 15	− 0·30	− 2·0
,, 19	− 0·41	+ 1·7
,, 23	− 0·61	+ 4·4
Nov. 13	− 0·37	+ 2·7

The Moon's R.A. and N.P.D. were interpolated with second differences from the hourly ephemeris in the Nautical Almanac, on two assumptions of longitude. The parallaxes were then computed from the formulæ—

Parallax in R.A. $= \frac{a.\sin h}{\sin 1''} + \frac{a^2 \sin 2h}{\sin 2''} + \frac{a^3 \sin 3h}{\sin 3''}$,

where

$$a = \sin p \,.\, \cos \phi \,.\, \sec \delta$$

$$\tan \delta^1 = \left(1 - \frac{\sin p \,.\, \sin \phi}{\sin \delta}\right) \frac{\sin h^1}{\sin h} \tan \delta.$$

In these formulæ δ and h are the geocentric declination and hour angle respectively; δ^1 and h^1 the apparent values; p is the Moon's equatorial horizontal parallax corrected for the latitude of the place; ϕ the geocentric latitude.

For the *Augmentation* of the Moon's semidiameter the approximate apparent altitude was computed, and the *Augmentation* taken from the table in LOOMIS' *Astronomy*, 7th edition, page 378. A constant correction of $-2''\cdot00$ was applied to the augmented semidiameter, all the occultations having been disappearances at the Moon's dark limb.

COMPARISONS of the CHRONOMETERS used for OCCULTATIONS with the TRANSIT CLOCK.

Approximate Local Mean Time.	Observer.	Time by the Transit Clock.	Transit Clock Slow on Local Sidereal Time.	Name of Chronometer.	Corresponding Time by the Chronometer.	Chronometer Slow on L. M. T.
1874. d h		h m s	s		h m s	m s
Oct. 14. 7	T	20. 15. 10·0	+ 15·07	Q	6. 42. 11·5	− 1. 3·09
8	T	21. 47. 14·0	+ 15·18	Q	8. 14. 0·5	− 1. 3·07
Oct. 15. 7	T	20. 31. 43·0	+ 17·28	Q	6. 54. 46·5	− 1. 1·51
8	T	21. 39. 8·0	+ 17·35	Q	8. 2. 0·5	− 1. 1·48
Oct. 19. 7	T	21. 19. 29·0	+ 24·71	Q	7. 26. 45·0	− 0. 58·06
8	T	22. 15. 5·0	+ 24·76	Q	8. 22. 12·0	− 0. 58·12
Oct. 23. 7	J	20. 54. 41·0	+ 32·09	L	6. 48. 15·5	− 2. 48·76
8	J	22. 27. 20·0	+ 32·20	L	8. 20. 39·5	− 2. 48·84
Nov. 12. 8	NI	0. 0. 2·0	+ 2·63	M	8. 30. 15·5	+ 0. 54·29
13. 7	T	22. 29. 55·0	+ 3·15	M	6. 56. 22·5	+ 0. 59·66
14. 8	NI	0. 4. 25·0	+ 3·52	M	8. 26. 35·0	+ 1. 6·13

OCCULTATIONS of FIXED STARS by the MOON, observed at HONOLULU.

[All are disappearances at the Moon's dark limb.]

1874.	Observer.	Telescope.	Star.	Name of Chronometer.	Recorded Time of Disappearance.	Correction to Chronometer.	Local Mean Time.	No.
					h m s	m s	h m s	
Oct. 14	T	6-inch Eq.	Wash. M.C.Z. 100, 19 .	Q	6. 52. 7·3	−1. 3·09	6. 51. 4·2	1
,,	T	,,	Yarnall 6962.........	Q	7. 4. 0·5	−1. 3·09	7. 2. 57·4	2
,,	T	,,	Yarnall 6964.........	Q	7. 13. 59·7	−1. 3·09	7. 12. 56·6	3
Oct. 15	T	,,	9m. $17^h.39\cdot1^m, -28°.41'$.	Q	7. 33. 51·0	−1. 1·49	7. 32. 49·5	4
,,	T	,,	8m. $17^h.39\cdot6^m, -28°.35'$.	Q	7. 37. 13·8	−1. 1·49	7. 36. 12·3	5
,,	T	,,	9m. $17^h.39\cdot2^m, -28°.41'$.	Q	7. 38. 53·0	−1. 1·49	7. 37. 51·5	6
,,	T	,,	O. Arg. S. 17202	Q	7. 40. 56·9	−1. 1·49	7. 39. 55·4	7
,,	T	,,	9m. $17^h.39\cdot9^m, -28°.22'$.	Q	7. 49. 48·0	−1. 1·48	7. 48. 46·5	8
,,	T	,,	10m. $17^h.40\cdot1^m, -28°.22'$.	Q	7. 56. 8·7	−1. 1·48	7. 55. 7·2	9
Oct. 19	T	3¾-inch ..	38 Capricorni	Q	7. 46. 35·0	−0. 58·09	7. 45. 36·9	10
Oct. 23	J	,,	*e* Piscium	L	7. 0. 43·5	−2. 48·78	6. 57. 54·7	11
Nov. 13	T	,,	B.A.C. 6628	M	6. 46. 20·4	+0. 59·66	6. 47. 20·1	12
,,	NI	3-inch ...	,,	M	6. 46. 20·2	+0. 59·66	6. 47. 19·9	12

Oct. 23. Observed by Mr. Johnson.

CALCULATION of the LONGITUDE of HONOLULU from the observed OCCULTATIONS.

Approximate Local Mean Time.	No. of Star.	Greenwich Mean Time on the two assumptions of Longitude. (h m s; a. = 10. 31. 20·0 W.; b. = 10. 31. 40·0 W.)	Tabular Apparent Place of Moon's Center (corrected for Errors of Tables). R. A.	Tabular Apparent Place of Moon's Center (corrected for Errors of Tables). N. P. D.	Moon's Augmented Semi-diameter (corrected).	Apparent R. A. of Star.	Apparent N. P. D. of Star.	Authority for Place of Star.	Inferred Longitude.	Conditions as regards Difference of Latitude of Moon and Star.
1874. d h m		h m s	h m s	° ′ ″	′ ″	h m s	° ′ ″		h m s	
Oct. 14. 6. 51	1	a. 17. 22. 24·2	16. 42. 44·94	116. 46. 8·0	14. 57·02	16. 43. 41·97	116. 54. 6·6	Dr. B. A. Gould	10. 31. 28·4	Favorable.
		b. 44·2	45·67	10·0						
7. 3	2	a. 17. 34. 17·4	16. 43. 4·81	116. 46. 18·0	14. 56·48	16. 44. 4·72	116. 39. 32·8	,,	10. 31. 26·8	Favorable.
		b. 37·4	5·55	19·9						
7. 13	3	a. 17. 44. 16·6	16. 43. 21·89	116. 46. 24·7	14. 56·09	16. 44. 26·31*	116. 42. 21·8	Yarnall 6964	10. 31. 20·9	Favorable.
		b. 36·6	22·63	26·6						
Oct. 15. 7. 33	4	a. 18. 4. 9·5	17. 38. 25·43	118. 29. 10·6	15. 5·13					
		b. 29·5	26·20	11·6						
7. 36	5	a. 18. 7. 32·3	17. 38. 31·22	118. 29. 2·1	15. 5·02					
		b. 52·3	31·99	3·0						
7. 38	6	a. 18. 9. 11·5	17. 38. 34·06	118. 28. 57·9	15. 4·97					
		b. 31·5	34·84	58·8						
7. 40	7	a. 18. 11. 15·4	17. 38. 37·64	118. 28. 52·4	15. 4·89	19. 39. 43·94*	118. 25. 2·3	Ö. A. 17202	10. 31. 18·5	Favorable.
		b. 35·4	38·40	53·3						
7. 49	8	a. 18. 20. 6·5	17. 38. 53·11	118. 28. 28·3	15. 4·58					
		b. 26·5	53·88	29·1						
7. 55	9	a. 18. 26. 27·2	17. 39. 4·37	118. 28. 10·2	15. 4·34					
		b. 47·2	5·15	11·0						
Oct. 19. 7. 46	10	a. 18. 16. 56·9	21. 26. 47·25	110. 53. 54·1	16. 4·42	21. 27. 52·42	110. 48. 28·9	Dr. Gould	10. 31. 29·1	Favorable.
		b. 17. 16·9	48·02	50·0						
Oct. 23. 6. 58	11	a. 17. 29. 14·7	1. 1. 20·56	85. 15. 8·8	16. 51·18	1. 1. 55·95	85. 0. 40·9	Gr. New 7-yr. and 9-yr. Cats.	10. 31. 29·6	Unfavorable.
		b. 34·7	21·31	2·8						
Nov. 13. 6. 47	12	a. 17. 18. 40·0	19. 15. 34·35	118. 1. 58·7	15. 17·83	19. 16. 40·69	118. 6. 32·0	Gr. 9-yr. Cat.	10. 31. 23·7	Favorable.
		b. 19. 0·0	35·14	57·5						

* These star places are unsatisfactory.

Giving each day the weight 1, and rejecting only October 15, the mean result from the occultations is $10^h. 31^m. 26^s{\cdot}9$.

We have, therefore, the following determinations of the longitude of Honolulu station :—

	h m s
By the Meridional Transits of the Moon......	10. 31. 26·0 W.
By the Zenith Distances..................	10. 31. 27·3 „
By the Occultations of Stars	10. 31. 26·9 „

67. In the year 1868, M. Fleuriais, at his station in Emma Street, observed 19 meridional transits of the Moon's first limb and 8 of the second limb. His observations are published in detail in the additions to the *Connaissance des Temps* for 1872. The result reduced to APUA Station is $10^h. 31^m. 22^s{\cdot}25$, a determination of great value, M. Fleuriais having had much experience of this description of observation; and, which is equally important, the errors of the lunar tables having been very satisfactorily determined at Washington, Oxford, and Greenwich. It depends, however, upon a single observer.

In the next section will be found the account of an attempt to connect Honolulu with San Francisco by chronometers, the result giving the longitude of Honolulu $10^h. 31^m. 33^s{\cdot}2$, which, however, has little value, as explained hereafter.

Weights being given to the above lunar results according to the number of observers, that is to say, the mean obtained in 1874–5 by transit and altazimuth having the weight 4, and M. Fleuriais' the weight 1, and giving the occultation result the weight 5, the resulting longitude is—

$$10^h. 31^m. 26^s{\cdot}3 \pm 2^s \text{ (say).}$$

The longitude used for the computation of the tabular quantities required in the final equations representing the observations of the Ingress of *Venus* is $10^h. 31^m. 27^s{\cdot}3$ West of Greenwich; the Greenwich times, therefore, require the correction, $\delta t = -1^s{\cdot}0$.

CHRONOMETRIC CONNECTIONS.

68. It was understood to be an essential part of the programme at Hawaii that the relative longitudes of some of the more distant islands should be determined; and this would have been done, although perhaps not so thoroughly, had the observations of the Transit of *Venus* failed.

The stations that were chronometrically connected with the head station at Honolulu (Apua) were the observatories of Professor Forbes at Kailua, Hawaii (Owyhee) and of Mr. R. Johnson at Waimea, Kauai (Atooi), distant 150 and 110 nautical miles respectively from Honolulu.

The details of the determination of local time at the three stations will be found in their respective sections.

69. The chronometers supplied to the Expedition from the Royal Observatory, Greenwich, were—

A.	Brockbank, 602.	Box 2-day.	Five beats in two seconds.	Solar.	
B.	M. Tobias, 561.	do.	Beating half-seconds.	Solar.	
C.	Dent, 2667.	do.	do.	do.	
D.	Molyneux, 2189.	do.	do.	do.	
E.	Weichart, 2339.	do.	do.	do.	
F.	Cotterell, 311.	do.	do.	do.	
H.	Webb, 5380.	do.	do.	Sidereal.	
J.	Fletcher, 2705.	do.	do.	do.	
K.	Norris, 828.	do.	do.	Solar.	
L.	Blackie, 538.	do.	do.	do.	
M.	Cotterell, $\frac{933}{2618}$.	do.	do.	do.	
O.	M'Cabe, 160.	Box 1-day.	Five beats in two seconds.	Solar.	*Very small.*
P.	Molyneux, 5174.	do.	Half-seconds.	Solar.	Not compensated. *Balance brass.* Small.
Q.	Park. and Frod., 1095.	Box 2-day.	Half-seconds.	Solar.	Small.
R.	Arnold, 555.	Box 1-day.	Half-seconds.	Solar.	
S.	Arnold, 6062.	Pocket 1-day.	Five beats to two seconds.	Solar.	

In addition to the above there were used:—

G.	Fletcher, 1050.	Box 2-day.	Half-seconds.	Solar.	Belonging to Captain Tupman.
N.	Leplastrier.	Box 8-day.	Half-seconds.	Sidereal.	Lent by Mr. W. De la Rue.
U.	Arnold & Dent, 756.	Box 2-day.	Half-seconds.	Solar.	The Chronometers of H.M.S. *Tenedos.*
V.	E. T. Massey, 110.	do.	do.	do.	
W.	McGregor & Co., 3795.	do.	do.	do.	
RH.	Barraud, 982.	do.	do.	do.	The Chronometers of H.M.S. *Reindeer.*
RM.	Muirhead, 2169.	do.	do.	do.	
RB.	Birchall, 1.	do.	do.	do.	

Mr. David Flitner, chronometer maker of Honolulu, most generously lent the following six chronometers:—

AA.	H. Frodsham, 2022.	Box 2-day.	Half-seconds.	Solar.
BB.	Bliss & Creighton, 735.	do.	do.	do.
CC.	Black & Murray, 527.	do.	do.	do.
EE.	Roskell, 511–41446.	do.	do.	do.
FF.	Negus, 1123.	do.	do.	do.
GG.	Dent, 2397.	do.	do.	do.

Captain Daniel Smith, Harbour Master at Honolulu, also kindly lent the chronometer—

DD. G. E. Frodsham, 6551. Box 2-day. Half-seconds. Solar.

It may be stated here that the chronometers J, L, and N formed part of Mr. Johnson's equipment at Waimea after 1874, November 6.

Chronometers O and Q were with Professor Forbes at Kailua.

P was overwound during the first run.

R was kept in use at Honolulu for comparing clocks.

The chronometers U, V, and W were generally employed as the portable watches to be carried ashore for comparison of chronometers.

70. The 18 chronometers first on the above list were lodged 1874, October 2, under the stage whence the model (*see* plan) was observed. They were compared with the transit clock every Sunday at noon, which served to indicate those which had the steadiest rates. O and S were very unsteady, while H, G, B, C, D, and M seemed to be the most reliable. The temperature was very uniform, at about 70°.

On 1874, November 2, O and Q were sent to Kailua. On November 6, J, L, and N, were sent to Waimea.

71. Captain Cator, of H.M.S. *Scout* having decided to send H.M.S. *Tenedos* to Kailua for a short time, for the purpose of rendering assistance to Professor Forbes during the Transit of Venus, advantage was taken of this opportunity for comparing the transit clocks at Honolulu and Kailua.

On December 5, at 4 p.m., the chronometers E, F, K, and M were placed on board the *Tenedos*, and well bedded in tow. U, V, and W occupied their own places in the ship's chronometer box. The same evening the seven were compared with the transit clock at Apua by Mr. Nichol and myself using M, V, and W, to be carried ashore.

72. Here it will be convenient to describe once for all how the chronometers that never left the vessel were habitually compared with the transit clocks on shore. At Honolulu the landing-place for ships in harbour was 1,300 yards distant from the observatory at Apua. The portable chronometers were slowly carried by hand this distance, never placed in a vehicle. The three solar chronometers used as portable watches (generally U, V, and W,) were compared with the others, which may be called *ship* chronometers, then taken on shore in a small boat, carried to the transit clock and compared with it by coincidence of beats, taken back to the ship without loss of time, and again compared with the ship chronometers. Everyone of these operations was performed personally by Mr. Nichol or by myself. The comparison of the portable watches with the others was effected by the same two observers, one of whom gave signals with the beats of the ship chrono-

meters, while the other estimated the time to the nearest tenth of a second by the portable watches. They then changed places and the first observer gave signals from the portable watches. This method eliminated the errors of comparing, and was less fatiguing than taking a sidereal chronometer all round for coincidence of beats.

73. The *Tenedos* sailed the same night, December 5, for Kailua, Lieutenant Lloyd kindly undertaking the winding. She arrived at Kailua on the morning of December 7, when Professor Forbes, assisted by Lieutenant Lloyd, without loss of time compared the chronometers with his Transit Clock by means of Q, V, and W.

The *Tenedos* sailed from Kailua on December 9 at 2 p.m. Immediately before her departure Professor Forbes made another complete comparison with his clock, using the same three portable watches. She arrived at Honolulu on the morning of December 10, when Mr. Nichol and I made the comparison with the Transit Clock, using R, V, and W for the purpose. This completed the first run to Kailua. Good observations for local time were obtained at both stations in connection with the comparisons.

74. After the Transit of Venus, the work of connecting the stations was commenced. It was arranged by Captain Cator that the *Tenedos* should make all the runs. Captain Van der Meulen, her commander, entered into it with spirit, and to his valuable assistance the success of these somewhat long and tedious operations was due. A proper berth was fitted up on the lower deck of the *Tenedos*, on the lockers round the mainmast. The chronometers, in their own gymbal-boxes with the lids removed, were placed, two and two, in well padded boxes, which were placed in the prepared berth, surrounded by about 8 inches of horse-hair padding to check the vibrations of the screw propeller. On December 13, 20 chronometers were thus placed; the three belonging to the *Tenedos* remained in their own berths in the captain's cabin.

75. The *Tenedos* made the following journeys with the chronometers:—

	h	
1874, December 14.	3.	Left Honolulu.
	22.	Arrived at Kailua.
17.	1.	Left Kailua.
	21.	Arrived at Honolulu.
19.	0.	Left Honolulu.
20.	1.	Arrived at Waimea.
	6.	Left Waimea.
21.	0.	Arrived at Honolulu.
22.	2.	Left Honolulu.

	h	
1874, December	22. 23.	Arrived at Waimea.
	23. 6.	Left Waimea.
	24. 0.	Arrived at Honolulu.
1875, January	2. 3.	Left Honolulu.
	22.	Arrived at Kailua.
	4. 8.	Left Kailua.
	5. 12.	Arrived at Honolulu.
	9. 6.	Left Honolulu.
	22.	Arrived at Waimea.
	10. 8.	Left Waimea.
	11. 22.	Arrived at Honolulu.

76. From December 14 to December 21, I went in charge of the chronometers; from December 22 to January 12, Mr. Nichol was in charge of them. They were wound every day at noon.

Immediately on arrival at a station, and immediately before departing, the chronometers were compared with the Transit Clock, three chronometers being used for this purpose, as before described, the comparisons being made by the responsible observers with as little delay as possible.

At Kailua the portable chronometers had to be carried about a quarter of a mile from the landing place to the Transit Observatory; at Waimea about half a mile.

77. In reducing the comparisons, the error of each portable watch on *local* mean solar time at the instant of its comparison with the Transit Clock was first found, assuming for this purpose the following longitudes of the observatories:—

	h	m	s
Honolulu......	10.	31.	25 W.
Kailua........	10.	24.	0 W.
Waimea	10.	38.	40 W.

As each ship chronometer was compared with each portable chronometer before and after the latter was compared with the Transit Clock, the error of each traveller on local mean time was directly obtained corresponding to the instant of the latter comparisons. The separate errors derived from each of the three portable watches never differ many hundredths of a second.

78. The whole of the comparisons of the portable chronometers with the standard timekeepers at the three stations are exhibited in Table XII. Of the determination of the errors of the ship chronometers, it is thought sufficient to give the specimens in Table XIII., while their errors on each day are given in Table XIV. The stationary and travelling rates are shown

in Table XV., as well as the differences of longitude inferred by each chronometer.

79. From Table XV. we have the following results for the difference of longitude between Honolulu (Apua) and Kailua observatories :—

	m s
By the first run, 1874, Dec. 5 to Dec. 10 (7 chronometers)	7. 24·38
By the second run, 1874, Dec. 14 to Dec. 18 (22 chronometers) ..	7. 24·65
By the third run, 1875, Jan. 2 to Jan. 6 (22 chronometers)	7. 24·89
Mean, Kailua transit east of Honolulu (Apua)	7. 24·64

And for the difference of longitude between Honolulu and Waimea we have :—

	m s
By the first run, 1874, Dec. 19 to Dec. 21 (22 chronometers)	7. 13·69
By the second run, 1874, Dec. 22 to Dec. 24 (22 chronometers) ..	7. 13·31
By the third run, 1875, Jan. 9 to Jan. 12 (22 chronometers)......	7. 13·44
Mean, Waimea Observatory west of Honolulu (Apua)	7. 13·48

80. In the year 1872 Professor Forbes and I made some comparisons to discover our relative personal equation, by observing many stars about the same time in the same instrument, with the following results :—

$$\left.\begin{array}{llll} \text{May 21, clock slow, } T - F & = +0^s{\cdot}04 & \text{weight} & 2 \\ \text{May 22,} \quad \text{,,} \quad \text{,,} & = +0{\cdot}13 & \text{,,} & 2 \\ \text{May 27,} \quad \text{,,} \quad \text{,,} & = +0{\cdot}08 & \text{,,} & 2 \\ \text{June 10,} \quad \text{,,} \quad \text{,,} & = -0{\cdot}13 & \text{,,} & 1 \end{array}\right\} \text{Mean } +0^s{\cdot}05.$$

At Kailua, on December 15, 1874, a rather unsatisfactory comparison was made which gave $T - F = +0^s{\cdot}04$. These results tend to show that there is no great difference between Professor Forbes and myself ; consequently no correction for personal equation has been applied to the difference of longitude between Honolulu and Kailua.

No data exist for comparing Mr. Johnson's mode of observing with mine ; the difference of longitude, therefore, between Waimea and Honolulu is affected by this relative personal equation to an unknown extent. Mr. Johnson used a half-seconds chronometer when observing transits ; at Honolulu, of course, the clock was employed.

ATTEMPT TO CONNECT HONOLULU WITH SAN FRANCISCO.

81. H.M.S. *Reindeer*, Commander C. V. ANSON, R.N., was to convey the last of the party from Honolulu to San Francisco, and as it was probable that, at that season of the year, she would carry westerly winds all the way and make a short passage, it was resolved to employ the chronometers to measure the meridian distance. Her departure from Honolulu was fixed for March 20.

82. The errors of the chronometers were determined by observations of the Sun, with a reflecting circle by Troughton and Simms divided to 20″ and read by three verniers, the Sun's rays being reflected from mercury under a cover of glass in the usual manner to obtain the double altitude.

Mr. Noble called the seconds from the sidereal chronometer N, which was chosen on account of its loud beat, distinctly audible to the observer with the circle. Five double altitudes of one limb were taken, the circle and the cover of the mercury trough were then reversed, and five double altitudes of the other limb taken, all three verniers being read each time.* The chronometer N was compared, by coincidence of beats, with the two solar chronometers Q and R (which were not disturbed) before and after every set of observations, and thus the observations gave the errors of these three chronometers with equal accuracy. The errors of the others were obtained by comparing them in the usual way with N, Q, and R, about noon each day. The habits of observing and comparing were exactly similar at Honolulu and at San Francisco, to avoid systematic errors. The Sun was observed 3^h or 4^h from the meridian in the morning and in the afternoon. It will be sufficient to give as an example the actual observations made on one day; for instance, those on 1875, March 9, Table XVI. The circle reading in the *fifth* column is the mean of the three verniers. The index correction was found to be 22″, additive when the circle was read backwards. The N.P.D. of the Sun and the equation of time have been interpolated from the *Nautical Almanac* for the mean of the five recorded times, assuming the longitude to be $10^h. 31^m. 14^s$ west. The refraction has been computed, for the mean of each five observed altitudes, from the Greenwich Tables. The semidiameter employed is the mean of all the daily measurements.

83. Table XVII. is an abstract of all the errors obtained before leaving Honolulu. Table XVIII. is a similar abstract of errors obtained at Mare Island, San Francisco, where the *Reindeer* arrived on the morning of April 9. Instead of making a short passage under favorable circumstances, she was

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* The darkening glass fitted to the eyepiece of the telescope was always used.

unfortunately blown to the southward by a cold northerly gale, which caused a fall of temperature in the chronometer boxes to the extent of 15° Fahrenheit, and lengthened the voyage seven or eight days, the *Reindeer* being unable to steam against the wind and sea.

Table XIX. shows the average rates of the chronometers before and after the voyage, the mean of them, which are the adopted travelling rates, and the difference of longitude between the stations as derived from each chronometer.

84. On the arrival of H.M.S. *Reindeer* at the U.S. Navy Yard, Mare Island, the members of the Expedition were courteously received by Commodore PHELPS, U.S.N., the Commandant of the Navy Yard, and all possible assistance was rendered. The circle observations were taken on the summit of an elevation in the Navy Yard, on which stood a small observatory, and near it an inscribed stone on which the mercury trough was placed. This stone was connected with the triangulation of the coast survey by Professor GEORGE DAVIDSON who, by permission of the Superintendent, kindly supplies the information regarding the longitude of the station.

85. The longitude of a station in Washington Square, San Francisco, from the Washington Observatory, D.C., was determined by elaborate telegraphic signals in the year 1869 (*U.S. Coast Survey Report*, 1870). The inscribed stone on the hill in the Navy Yard was connected with the triangulation of San Francisco Harbour, and thus it was found to be in—

Latitude $38°. 5'. 53''\cdot 1$ North.
Longitude $8^h. 9^m. 5^s\cdot 08$ West of Greenwich.

86. The mean difference of longitude between Honolulu and the Navy Yard as given by the chronometers, rejecting only Q, S, and RH, on account of their small size and previous erratic movements, is—

$$2^h. 22^m. 28^s\cdot 19 \pm 3^s\cdot 0.,$$

whence the longitude of Honolulu appears to be—

$$10^h. 31^m. 33^s\cdot 2 \pm 3^s\cdot 0.,\text{ West from Greenwich.}$$

a determination to which I can attribute but little value.

G. L. TUPMAN.

OBSERVATION OF THE INGRESS OF VENUS, 1874, DEC. 8.

REPORT OF CAPTAIN G. L. TUPMAN, R.M.A.

The weather on the 8th of December 1874, was all that could be desired. The sky was cloudless nearly all day, and of a deep blue, indicative of extreme clearness. The N.E. trade wind blew lightly, not disturbing the unprotected telescopes.

Great interest was taken in our proceedings by the native population of Honolulu. Every tree in the neighbourhood of the inclosure, and every roof commanding a partial view within, bore its living freight. Anticipating some possible annoyance to us, Her Majesty, QUEEN KAPIOLANI, had taken the precaution to make it known among the natives that "Silence" must be maintained, and not a sound disturbed us all the afternoon. A great many natives presented themselves at the gates, expecting to be permitted to view the transit in the telescopes. Captain Cator, at my request, surrounded the inclosure with a cordon of Marines, from H.M.S. *Scout*, chiefly with a view of keeping silence.

HER MAJESTY the QUEEN and other members of the Royal Family most considerately abstained from entering the inclosure on that day, although they were frequent visitors at other times.

Major WODEHOUSE, Her Britannic Majesty's Commissioner, most kindly tendered his assistance, and remained within the inclosure all the time. I cannot refrain from here placing on record how much we were indebted to his kindness and courtesy during our long stay in Honolulu.

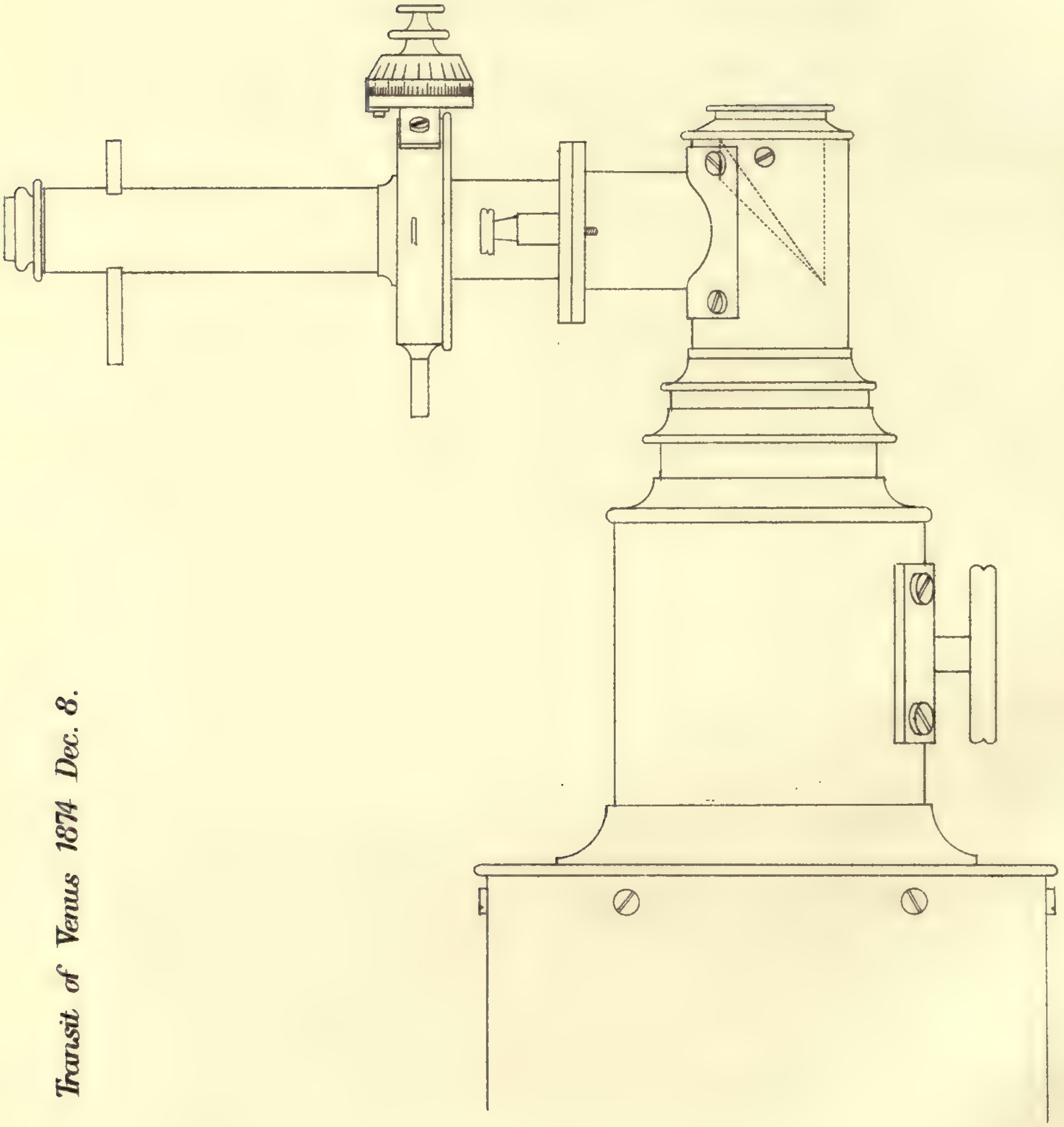
The telescopes used at Honolulu were—

(1.) An equatorial of 6 inches clear aperture and 89 inches focal length, by Messrs. T. COOKE AND SONS, of York, which had been purchased by the Government from the executors of the late B. D. NAYLOR, Esq.;

(2.) An equatorial of $4\frac{1}{2}$ inches clear aperture and 69 inches focal length, by the same makers, my own property;

(3.) A telescope of $3\frac{5}{8}$ inches clear aperture and 57 inches focal length, by DOLLOND, mounted on a wooden tripod stand, with vertical and horizontal motions;

Transit of Venus 1874 Dec. 8.



Arrangement of the Double image Micrometer and Solar diagonal reflector.

Scale one-half natural size.

To face page 39.

DANGERFIELD LITH 22. BEDFORD ST. COVENT GARDEN.

(4.) A telescope of 3 inches aperture and 45 (?) inches focal length, by T. COOKE, on a tripod stand, my own property.

These four telescopes, in common with most of the telescopes employed on the Transit of Venus Expeditions, were fitted by Messrs. Troughton and Simms with special means for observing the Sun, which, although well known, it is proper to describe here.

The cone of rays from the object glass is intercepted, before the primary focus, by a glass prism, one face of which is adjusted to an inclination of 45° to the optic axis of the telescope, so as to reflect a portion of the light approximately at right angles to the optic axis. About 90 per cent. of the light and heat passes through the prism and is dispersed. The eye-pieces of whatever character are inserted immediately above the prism. The 6-inch and the $4\frac{1}{2}$-inch equatorials were both fitted with new double-image micrometers by Messrs. Troughton and Simms. Plate III. represents one of these instruments in position. The light is further toned down by an achromatised wedge of neutral tint glass, placed between the two lenses nearest the eye. The equality of the intensity of the two images is adjusted by the screw which has the power of slightly altering the position of the axis of the micrometer with regard to the optic axis of the object glass. The adjustment of the reflecting prism is perfect when the micrometer can be rotated about its own axis without altering the relative intensity of the two images. This adjustment is liable to derangement from the circumstances that the prism must not be too closely confined in its cell, as it is liable to become very much heated when in use. No difficulty was experienced with either telescope at Honolulu in regulating the intensity of the two images. This double-image micrometer is described at length in the *Memoirs* of the Royal Astronomical Society, XV. 199, and in the *Monthly Notices*, VI. 229, and X. 160. One half of the divided lens was fixed, the other was moved by the micrometer screw. They were not, however, provided with position-circles.

Both the equatorials were mounted upon iron pillars, which stood upon piers of brickwork built up from the coral rock. The driving clocks, which performed well, were adjusted to the Sun's apparent motion. The 6-inch instrument was sheltered by a wooden hut, the roof of which could be removed in pieces. The $4\frac{1}{2}$-inch instrument was protected, when not in use, by a small hut of wood and canvas, which was removed entirely when the instrument was in use.

The Secondary Clock Dent 2012, the pendulum rod of which was of wood, was mounted in the 6-inch equatorial hut, and was compared, when

required, with the Transit Clock in the same manner as the Altazimuth Clock.

Several days before the Transit of Venus, Lieutenants OLDHAM, SHAKESPEAR, and CLAPP, of H.M.S. *Scout*, kindly attended at the observatories to rehearse the intended operations. Lieut. Oldham was to assist Mr. Nichol, Lieut. Shakespear to assist Mr. Noble, while Lieut. Clapp was to aid me; and all this assistance was most effective, and enabled the work to be well and quickly done when every minute was precious.

Every observer had an adjustible seat, so that he could be perfectly at ease.

At noon Mr. Nichol and I made a complete comparison of all the clocks and chronometers intended for use, and provided for the contingency of any of them stopping at a critical time.

At 1^h I carefully adjusted the direct-vision spectroscope on the $4\frac{1}{2}$-inch equatorial. Although I attach very little value to the observation made with the spectroscope, it was sufficiently interesting to be worth recording. The spectroscope was made by Mr. Browning, and consisted of a direct-vision prism, of five components, two flint and three crown cemented together, sufficiently large to transmit a pencil 1·2 inches by 0·7 inches, with collimator and examining telescope each of 7 inches focal length. The slit was opened and closed by a small micrometer-screw acting against a spring. I determined the value of a revolution of the screw by opening and closing the slit through measured ranges under the microscope. During my observation the slit was open 0·0016 of an inch. The power of the combination was about 55 or 60 diameters. In the focus of the eye-lens of the small examining telescope I inserted an opaque screen with a narrow slit in it, the width of which was about $\frac{1}{30}$th of an inch, and the length rather more than the breadth of the spectrum. The Fraunhofer line C occupied the middle of this aperture, its apparent width or image of the opening of the slit being about one half of its breadth, so that the entire spectrum was cut off from view except the C line and a narrow strip on either side. The spectroscope was firmly attached to the telescope by a brass tube supporting it at its center of gravity. There was an opening in this tube giving access to the slit, which was of course placed exactly in the primary focus of the object-glass.

At $2^h. 30^m$ local mean time I placed the slit tangentially on the Sun's limb at the expected point of first contact. The hydrogen stratum or "chromosphere" was well defined. There was no prominence near the point of contact, but the outer limit of the chromosphere was irregular.

Mr. Clapp recorded the times from the solar chronometer C, which at $2^h. 25^m$ was $7^m. 55^s{\cdot}17$ *fast* on local mean time, and was gaining $0^s{\cdot}09$ per hour (*see* comparisons, page 62).

At $3^h. 14^m. 17^s{\cdot}5$ by the chronometer I first detected the planet entering on the chromosphere. At $3^h. 14^m. 38^s$ the curvature was so decided I was sure that it was caused by the advancing limb of the planet. At $3^h. 14^m. 47^s$ I found it difficult to see the red line between the Sun's limb and the planet. At $3^h. 14^m. 56^s$ I imagined the red line was severed and contact took place. At $3^h. 15^m. 15^s$ there was a long black division in the middle of the C line which was bright on either side, while the Sun's limb was just visible among the minute irregularities on the edge of the slit. I felt sure that the contact was passed.*

I then removed the spectroscope and proceeded to the 6-inch equatorial, with which Mr. Nichol had been observing the external contact. Putting in the double-image micrometer and adjusting it as quickly as possible, I made the following measures of the distance between the obtuse cusps, Mr. Clapp counting aloud the seconds from the Equatorial Clock, and recording the observations:—

Equatorial Clock Times.	Measures of Obtuse Cusps. Micrometer Reading.
h m s	r
20. 23. 38	4·592
20. 24. 17	4·320
20. 24. 39	4·235
20. 24. 51	4·200
20. 25. 12	3·895
20. 25. 28	3·995
20. 25. 42	3·715
20. 25. 56	3·696

It should be remarked here that the integer revolutions of the micrometer-screw were reckoned in one direction only. When the two images coincided and formed but one image, the micrometer-reading was approximately $10^r{\cdot}000$. During the above measures, which are all on one side of the zero, the focussing was slightly imperfect, as I discovered afterwards. The power of the micrometer eye-piece was 250.

I then removed the micrometer and put in the negative eye-piece, power 150, fitted with an achromatised neutral tint wedge. I looked very carefully for any fringe surrounding the planet, and for partial illumination of its disc.

* The local mean time of External Contact, inferred from the measures of cusps, is $3^h. 8^m. 42^s{\cdot}7$ which is $1^m. 41^s{\cdot}9$ later than the "spectroscopic" contact.

I called Mr. Clapp to look at it. The planet was then about one third on. Neither of us saw her entire disk, but we only spent a moment or two looking at it, for just then the driving clock, which was being driven with a light weight, stopped, and two or three minutes perhaps passed before things were right again. Having replaced the micrometer, when the planet was rather more than half on, I made the following three sets of measures of her diameter in the direction parallel to the Sun's limb, on either side of the zero, having carefully adjusted the focus:—

MICROMETER READINGS for DIAMETER of VENUS parallel to SUN'S LIMB.

1st Set.	2nd Set.	3rd Set.
r	r	r
2·875	16·870	2·900
2·845	16·920	Much "boiling."
2·916	16·918	2·886
3·145 (bad)	17·004	2·860
2·810	16·922	2·820
	16·955	2·836

The brasswork surrounding the reflecting prism had now become too much heated to be touched by the hand. The micrometer-screw, however, was at a considerable distance from the prism, and I do not suppose the value of one revolution could be sensibly affected.

As seen in the field of view of the double-image micrometer there was no trace of the illumination in the planet's atmosphere seen at this time by so many observers using Huyghenian eye-pieces. Had I seen it I should probably not have known how to measure the distance between the cusps.

When I judged that about five minutes remained before internal contact I began to measure the cusps, Mr. Clapp counting aloud the seconds from the clock.

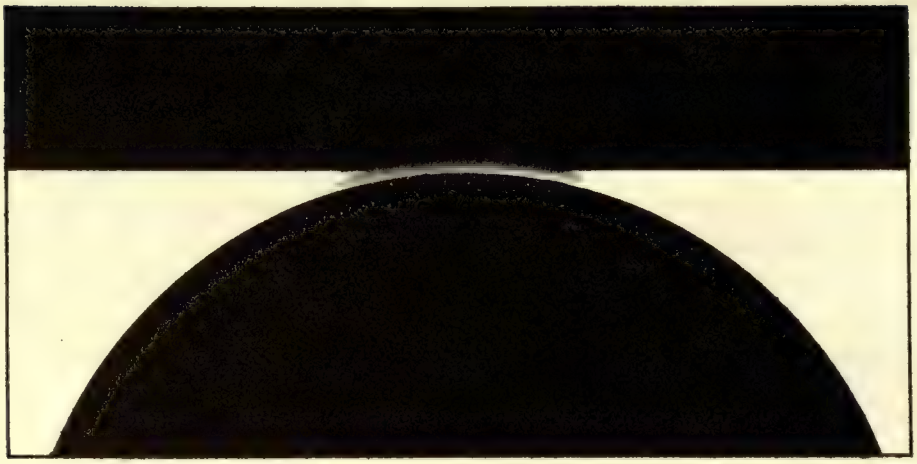
MEASURES of CUSPS before INTERNAL CONTACT.

Clock Time.	Micrometer Reading.	Clock Time.	Micrometer Reading.
h m s	r	h m s	r
20. 41. 0	4·336	20. 44. 11	6·002
20. 41. 30	4·590	20. 44. 23	6·270
20. 41. 52	4·890	20. 44. 36	6·436
20. 42. 8	4·915	20. 44. 47	6·645
20. 43. 31	5·700	20. 45. 1	6·918
20. 43. 44	5·804	20. 45. 25	7·466
20. 43. 53	5·860	20. 45. 43	7·755
20. 44. 1	5·985		

Transit of Venus 1874 Dec. 8, at Honolulu.

Diagrams illustrating the Internal Contact at Ingress.

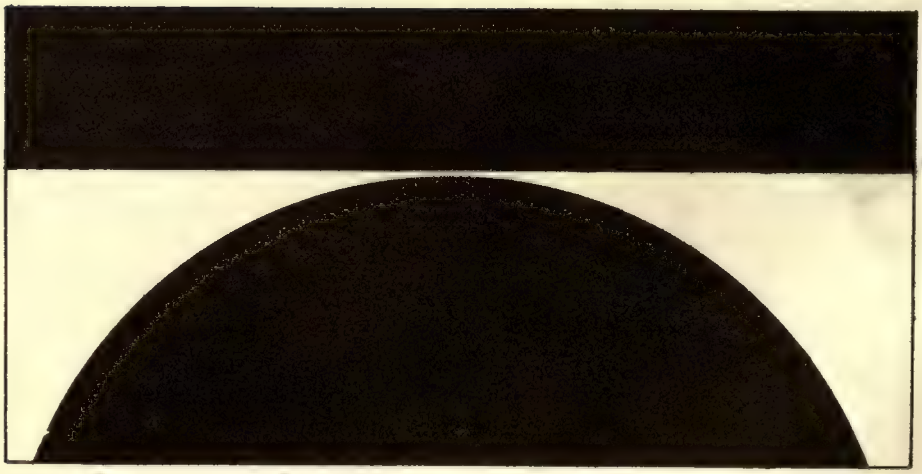
Fig. 1.



Local Sidereal time, $20^{h}.46^{m}.14^{s}\!\cdot\!5$ (Tupman, 6 inch refractor.)

(These Diagrams should be viewed at the distance of four feet.)

Fig. 2.



Local Sidereal time $20^{h}.46^{m}.32^{s}\!\cdot\!5$ (Tupman, 6 inch refractor.)

Dangerfield Lith. 22 Bedford St. Covent Garden

To face page 43.

After calling the reading $6^{r}{\cdot}918$ (at $20^{h}.\ 45^{m}.\ 1^{s}$) I placed the two images in coincidence to estimate the time remaining before internal contact. This I had frequently practised on the *model*, and generally was not more than 10 seconds in error. I remarked aloud to Mr. Clapp that it wanted a minute, and proceeded to take the two last cusp-measures. Up to this time the circumstances of the Ingress of Venus exactly resembled those seen in the model.

I drew out the micrometer at $20^{h}.\ 45^{m}.\ 43^{s}$ without reading it, laid it on the shelf and inserted the negative eye-piece, power 150, down to the pencil mark on it for focus. This I had repeatedly practised on the model, and always effected in 10 or 12 seconds. I was no longer than usual on this occasion. Mr. Clapp watched me, timed me I believe, and noticed that if anything I was quicker than usual. On looking in (at $20^{h}.\ 45^{m}.\ 55^{s}$ therefore) I saw the cusps separated such a distance that I thought it still wanted 30 seconds* of contact, but the image not being perfectly sharp I threw it out of focus with the rack motion, and brought it carefully in again. As I did so I perceived that the cusps were united by a narrow band or thread of light of sensible width, but faint, and instantly called "contact," though fearing I had missed it while focussing. This was at $20^{h}.\ 46^{m}.\ 2^{s}$. As the appearance at that instant made a vivid impression on my mind, I afterwards made a drawing of it (Plate IV., Fig. 1), and may here very properly describe it. The bright parts of the cusps were then far apart; the band of light connecting them merged into them so gradually it was impossible to say where the *points* of the cusps were. They no longer possessed the sharpness I had seen with the micrometer eye-piece some 20 seconds before. The band of light was of uniform width (calling *width* the direction perpendicular to the limbs) and of uniform shading for a considerable part of its length between where it merged into the cusps. It was sharply defined along the edge of the planet, but faded off gradually on its other border, where I expected to see the limb of the Sun. Everything hitherto having so closely resembled the appearances in the model, I felt certain that I had missed the contact while focussing, although I could not understand how it could have occurred so much sooner than I had expected. The preceding remarks refer to the instant $20^{h}.\ 46^{m}.\ 2^{s}$. by the clock.

Mr. Clapp went on steadily counting the seconds. I was surprised that the band of light did not change much in appearance for some time; it seemed a long time in comparison with model experience. There was no

* In the note book "30 seconds" is entered, but in the account which I wrote after the transit I said "20 seconds." Whether intentionally or not I cannot now tell. It is unimportant.

black drop nor *ligament.* The planet was perfectly circular, and nothing whatever disturbed the sharpness of its outline at the place of contact. The band of light [after a certain interval] gradually and imperceptibly brightened, and as Mr. Clapp said "twenty" it was sufficiently bright to induce me to consider the contact as established [by which I meant quite passed]. The clock time for this is $20^h. 46^m. 20^s{\cdot}0$. At that instant the general appearance was similar to the model a second or two after contact, as nearly as possible as represented in Fig. 2, Plate IV., which was drawn an hour or two afterwards.*

On concluding the micrometer-measures given below, that is, about half an hour after internal contact, I wrote some notes in the observing-book, including the following :—

"At the 20 seconds which I have recorded I am perfectly certain the contact was *passed*, established completely—not 'contact' properly speaking, for that implies some definite instant which was never observed. At that time, and for a second or two before, there was the *shadow* on the light at the point of contact, a phenomenon always seen with the model, but nothing like a ligament or black drop, although I looked carefully for such an appearance."

Much disheartened at the unsatisfactory nature of the observation of contact I withdrew from the telescope to look through the record of times, and at my request Mr. Clapp took my place and scrutinised the planet. I asked him if he could see a fringe of any kind near the periphery of the planet, of shadow surrounding it, or diffused light within. He said he saw nothing but a plain black sharply-defined circle. I called Major Wodehouse in also (not being able to commence "limb" measures immediately), and called his attention to the same points with the same result.

I then replaced the double-image micrometer, and made the following series of measures of the distance between the near limbs of the Sun and planet, and of the diameter of the planet, reversing the direction of measurement at $20^h. 55^m.$ and at $21^h. 2^m.$ when the position of the movable half-lens, with reference to the fixed half-lens, was changed, as indicated by a line drawn between the measures. At each change the telescope was re-pointed, to bring the point of contact exactly in the center of the very limited field of view, and the direction of measurement re-adjusted. It is here that the want of a position-circle is most felt.

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* In the reproduction of this diagram for the Astronomer Royal's "Parliamentary Report" the lithographer has incorrectly introduced a dark shadow between the limbs. Fig. 2, Plate IV., is a correct copy of the original sketch.

MEASURES of the DISTANCE between the near LIMBS of the SUN and PLANET after INTERNAL CONTACT.

Clock Times.	Micrometer Reading.	Clock Times.	Micrometer Reading.	Clock Times.	Micrometer Reading.
h m s	r	h m s	r	h m s	r
20. 49. 46	10·914	20. 54. 11	11·935	20. 59. 12	7·250
20. 50. 1	10·973	20. 54. 21	11·900	20. 59. 24	7·165
20. 50. 20	10·958	20. 54. 36	11·935	20. 59. 32	7·310
20. 50. 31	11·101	20. 54. 50	12·072	20. 59. 47	7·040
20. 50. 53	11·035	20. 55. 45	8·072	20. 59. 57	7·141
20. 51. 16	11·252	20. 56. 2	8·030	21. 0. 8	7·075
20. 51. 35	11·258	20. 56. 13	7·995	21. 0. 30	6·910
20. 51. 52	11·427	20. 56. 29	7·965	21. 0. 40	7·033
20. 52. 5	11·420	20. 56. 40	7·875	21. 0. 54	6·800
20. 52. 24	11·353	20. 56. 55	7·782	21. 1. 12	6·810
20. 52. 37	11·500	20. 57. 38	7·532	21. 1. 28	6·795
20. 52. 50	11·625	20. 57. 58	* 7·625	21. 1. 46	6·710
20. 53. 10	11·650	20. 58. 14	7·390	21. 2. 29	13·750
20. 53. 29	11·800	20. 58. 29	7·472	21. 2. 51	13·642
20. 53. 47	11·760	20. 58. 44	7·382	21. 3. 6	13·800
20. 53. 59	11·855	20. 58. 57	7·309	21. 3. 21	13·802

* Bad.

MEASURES of the DIAMETER of VENUS.

Micrometer Readings when the Images were in tangential contact.

r	r
16·915	3·100
16·990	3·055
16·944	2·990
16·977	2·910
16·915	3·000
16·975	2·945
16·910	2·900 eye fatigued
16·930	2·985
16·900	3·000
16·900	2·848 bad
	2·840 bad
	3·127

Between every two micrometer-measures the screw was rotated in opposite directions alternately, to eliminate any possible error that might arise from turning it always in the same direction. It is unfortunately not recorded in what direction these last measures of diameter were taken. I may or may not

have rotated the micrometer to place the head in a more convenient position, as I was at that time ignorant of the fact that this form of micrometer is liable to a variation of its zero as it is rotated about its axis. The measures of limbs, however, are practically independent of the zero, while for the cusp-measures the zero was determined immediately before them with the micrometer in its proper position.

The Sun was now approaching the western horizon. Lieut. Ramsden had secured 60 photographs, Mr. Nichol a series of micrometric-measures similar to my own, and Lieut. Noble the telescopic contact. The clocks and chronometers were then compared. Every observer made his notes in full before any conversation passed between us, and wrote his Report, as here given with no material alteration, the same evening.

TABLE A.—COMPARISONS of the TRANSIT and EQUATOREAL CLOCKS by intervention of the SOLAR CHRONOMETERS R AND C and inferred ERROR of the EQUATOREAL CLOCK, 1874, December 8.

Time by Transit Clock.	Time by Chronometer at Comparison with Transit Clock.	Time by Chronometer at Comparison with Equatoreal Clock.	Time by Equatoreal Clock.	Equatoreal Clock *slow* on Local Mean Time.	Observer.
h m s	h m s	h m s	h m s	s	
17. 6. 38·00	R 11. 56. 31·50	12. 8. 8·50	17. 18. 15·00	12·38	T
17. 47. 10·00	R 0. 36. 57·00	0. 32. 57·50	17. 43. 8·00	12·37	T
21. 57. 35·00	C 4. 54. 52·50	4. 57. 31·00	22. 0. 12·00	12·52	Ni
22. 16. 6·00	C 5. 13. 20·50	5. 0. 39·50	22. 3. 21·00	12·53	Ni

I now proceed to the discussion of these observations in order to put them in the form of final equations immediately available for the determination of the solar parallax, which was the special object of the Expeditions; premising that every observation resolves itself into a measure in a direction joining the apparent centers of the SUN and VENUS, as seen from the place of observation, and that the formulæ by which the local tabular distance of centers and the various co-efficients have been computed, were taken from the Astronomer Royal's paper in the *Monthly Notices of the Royal Astronomical Society*, Vol. XXXV., 277, the geocentric places of the SUN and *Venus* being taken from the ephemeris for every 10 seconds of Greenwich sidereal time computed from LEVERRIER's Tables by direction of the Astronomer Royal.

Let s, S, be the semi-diameters of *Venus* and of the SUN respectively expressed in revolutions of the micrometer-screw.

r, R, the tabular semi-diameters in seconds of arc.

$2m$, the micrometer measure in revolutions of the screw.

Δ, the tabular distance of centers.

ρ, the value of one revolution of the screw.

x^r, x'', the distance between the limbs that are nearly in contact, in revolutions and seconds of arc respectively.

Then when the center of *Venus* is without the SUN, and $2m$ is the measure of the *obtuse* cusps:

$$x^r = S + s - (S^2 - m^2)^{\frac{1}{2}} - (s^2 - m^2)^{\frac{1}{2}}$$

s is determined by observation; $S = \frac{R \cdot s}{r}$ with sufficient accuracy,

$$\rho = \frac{r}{s} + \frac{\delta r}{s}$$

$$x'' + \delta x'' = x^r \cdot \rho = \frac{x^r \cdot r}{s} + \frac{x^r}{s} \delta r$$

$$\text{or } \delta x'' = \frac{x^r}{s} \delta r.$$

The true distance of centers is

$$\Delta + \delta \Delta = R + \delta R + r + \delta r - (x'' + \delta x'')$$

whence the final equation—

$$0 = R + r - (\Delta + x'') - \delta \Delta + \delta R + (1 - \frac{x^r}{s}) \delta r$$

where $\delta \Delta$ is the sum of the corrections to the tabular parallax, R.A., and N.P.D. each multiplied by the proper factor for its effect on the distance of centers.

For the measures of *acute* cusps (near internal contact) the equation is—

$$0 = R - r - (\Delta - x'') - \delta \Delta + \delta R - (1 - \frac{x^r}{s}) \delta r$$

and for measures of near limbs (after internal contact)—

$$0 = R - r - (\Delta + x'') - \delta \Delta + \delta R - (1 + \frac{x^r}{s}) \delta r$$

With the 6-inch instrument we have, from the first series of measures of the diameter of *Venus*

$$s = 3^{r}\cdot517,$$

and from the second series

$$s = 3^{r}\cdot490.$$

The several determinations of the zero of the micrometer are—

$9^{r}\cdot891$ from the first series of double-diameters.

$10^{r}\cdot163$ from the limb measures between $20^{h}. 53^{m}. 59^{s}.$ and $20^{h}. 56^{m}. 40^{s}.$

$10^{r}\cdot100$ from the limb measures between $21^{h}. 0^{m}. 40^{s}.$ and $21^{h}. 3^{m}. 21^{s}.$

$9^{r}\cdot956$ from the second series of double-diameters.

For the reduction of the measures of *Cusps* the zero has been taken as $9^{r}\cdot891$; and the value of s, $3^{r}\cdot517$.

For the *limb* measures the zero has been taken $10^{r}\cdot130$; and s, $3^{s}\cdot490$.

$$R = 976''\cdot80 \qquad r = 31''\cdot42.$$

$$\text{Whence } \rho = \begin{cases} 8''\cdot932 + \cdot286\ \delta r \text{ for cusp measures.} \\ 9''\cdot002 + \cdot286\ \delta r \text{ for limb measures.} \end{cases}$$

Assumed astronomical latitude $21°. 17'. 56''\cdot3$ N.

„ longitude west of Greenwich $10^{h}. 31^{m}. 27^{s}\cdot3$.

Similarly for Mr. Nichol's observations with the $4\frac{1}{2}$-inch equatorial, we have, from the first series for diameter of *Venus*,

$$s = 2^{r}\cdot448$$

and zero $9^{r}\cdot996$ for the direction parallel to the Sun's limb.

and for the second series

$$s = 2^{r}\cdot434$$

zero $10^{r}\cdot000$ (direction not stated ; probably parallel to Sun's limb),

$$\text{and } \rho = \begin{cases} 12''\cdot835 + \cdot410\ \delta r \text{ for cusp measures.} \\ 12''\cdot913 + \cdot410\ \delta r \text{ for limb measures.} \end{cases}$$

The equations of distance of centers of the SUN and *Venus* for every observation with both instruments are exhibited in the following Tables B and C, (which also give the *time of contact* deduced from each micrometer measure of cusps,) taking the tabular semi-diameters as above, and assuming the mean solar parallax to be

$$8''\cdot950\ (1 + \tfrac{n}{100}).$$

The relative weights assigned to the cusp measures are arbitrary. The model practice proved that the measures taken in the last two minutes were about twice as accurate, for the object in view, as those taken between five and three minutes from contact.

TABLE B. EQUATIONS OF DISTANCE of the CENTERS of the SUN and VENUS from OBSERVATIONS near INTERNAL CONTACT with the Six-inch EQUATORIAL at HONOLULU. Assumed Longitude $10^h. 31^m. 27^s{\cdot}3$ W.

Recorded Time by the Equatorial Clock.	Greenwich Sidereal Time.	Tabular Distance of Centers.	Micrometer Measures.	Inferred Distance of Near Limbs.	Resulting Equation.							Inferred Greenwich Sidereal Time of Contact.	Weight.
												External Contact.	
h m s	h m s	′ ″	r	″	″			″				h m s s	
20. 23. 38	6. 55. 17·8	16. 28·50	5·299	11·04 + ·358 δ r	+ 8·68 =	− ·2249 n	+ ·7048 δ R.A.	− ·6451 δ N.P.D.	− ·0397 δ t	− δ R	− ·642 δ r	6. 50. 45·0 − 8·84 δ r	5
24. 17	55. 56·8	26·95	5·571	12·56 + ·403	8·71 =	− ·2251 n +	35	68	90		·597	50. 45·8 − 10·05	5
24. 39	56. 18·8	26·10	5·656	13·06 + ·418	9·06 =	− ·2251 n +	27	78	82		·582	50. 54·9 − 10·45	4
24. 51	56. 30·8	25·59	5·691	13·28 + ·425	9·35 =	− ·2252 n +	23	83	96		·575	51. 2·0 − 10·62	3
25. 12	56. 51·8	24·73	5·996	15·35 + ·492	8·14 =	− ·2254 n +	15	93	95		·508	50. 31·2 − 12·28	3
25. 28	57. 7·8	24·10	5·896	14·64 + ·469	9·48 =	− ·2254 n +	10	99	94		·531	51. 5·4 − 11·71	3
25. 42	57. 21·8	23·55	6·176	16·76 + ·537	7·91 =	− ·2255 n +	05	·6506	94		·463	50. 59·7 − 13·41	3
20. 25. 56	6. 57. 35·8	16. 23·00	6·195	16·96 + ·543 δ r	8·26 =	− ·2255 n	+ ·7000 δ R.A.	− ·6512 δ N.P.D.	− ·0393 δ t	− δ R	− ·457 δ r	6. 50. 34·3 − 13·54 δ r	2
				Mean with weights	+ 8·72 =	− ·2252 n	+ ·7024 δ R.A.	− ·6485 δ N.P.D.	− ·0392 δ t	− δ R	− ·5592 δ r	6. 50. 49·9 − 10·98 δ r	
												Internal Contact.	
20. 41. 0	7. 12. 39·8	15. 48·91	5·555	11·79 + ·377 δ r	+ 8·26 =	− ·2282 n	+ ·6662 δ R.A.	− ·6916 δ N.P.D.	− ·0362 δ t	− δ R	+ ·623 δ r	7. 18. 12·2 + 10·56 δ r	5
41. 30	13. 9·8	47·83	5·301	10·48 + ·336	8·03 =	− ·2282 n +	50	30	61		·664	18. 5·6 + 9·40	5
41. 52	13. 31·8	47·04	5·000	9·06 + ·290	7·40 =	− ·2282 n +	41	39	54		·710	17. 47·8 + 8·12	5
42. 8	13. 47·8	46·47	4·976	8·96 + ·286	7·87 =	− ·2282 n +	35	47	53		·714	18. 1·2 + 8·03	6
43. 31	15. 10·8	43·52	4·191	6·01 + ·192	7·87 =	− ·2282 n +	02	84	55		·808	18. 1·2 + 5·38	6
43. 44	15. 23·8	43·05	4·087	5·68 + ·182	8·01 =	− ·2283 n	+ ·6596	90	53		·818	18. 5·2 + 5·09	6
43. 53	15. 32·8	42·73	4·031	5·50 + ·176	8·15 =	− ·2283 n +	92	94	51		·824	18. 9·2 + 4·93	7
44. 1	15. 40·8	42·44	3·906	5·16 + ·166	8·10 =	− ·2284 n +	89	98	50		·834	18. 7·6 + 4·60	7
44. 11	15. 50·8	42·08	3·889	5·09 + ·162	8·39 =	− ·2283 n +	85	·7002	55		·838	18. 15·8 + 4·56	8
44. 23	16. 2·8	41·66	3·621	4·35 + ·138	8·07 =	− ·2283 n +	80	08	48		·862	18. 6·8 + 3·89	8
44. 36	16. 15·8	41·21	3·455	3·93 + ·126	8·10 =	− ·2283 n +	75	14	47		·874	18. 7·6 + 3·52	9
44. 47	16. 26·8	40·83	3·246	3·44 + ·110	7·99 =	− ·2283 n +	70	19	54		·890	18. 4·5 + 3·08	9
45. 1	16. 40·8	40·34	2·973	2·85 + ·092	7·89 =	− ·2283 n +	65	25	54		·908	18. 1·6 + 2·56	9
45. 25	17. 4·8	39·49	2·425	1·87 + ·060	7·76 =	− ·2283 n +	55	36	53		·940	17. 57·9 + 1·67	10
20. 45. 43	7. 17. 22·8	15. 38·86	2·136	1·42 + ·046 δ r	+ 7·94 =	− ·2284 n	+ ·6547 δ R.A.	− ·7046 δ N.P.D.	− ·0352 δ t	− δ R	+ ·954 δ r	7. 18. 3·2 + 1·27 δ r	10
				Mean with weights	+ 7·99 =	− ·2283 n	+ ·6589 δ R.A.	− ·7002 δ N.P.D.	− ·0353 δ t	− δ R	+ ·8384 δ r	7. 18. 4·9 + 4·52 δ r	
20. 46. 2	7. 17. 41·8	15. 38·21	. .	Fig. 1, Plate IV.									
20. 46. 20	7. 17. 59·8	15. 37·58	. .	Contact passed, Fig. 2, Plate IV	+ 7·80 =	− ·2284 n	+ ·6532 δ R.A.	− ·7061 δ N.P.D.	− ·0340 δ t	− δ R +	δ r	7. 17. 59·8	

TABLE B. EQUATIONS of DISTANCE of CENTERS (*continued*).

Recorded Time by Equatorial Clock.	Greenwich Sidereal Time.	Tabular Distance of Centers.	Micrometer Measures.	Inferred Distance of Near Limbs.	Resulting Equations.					
h m s	h m s	′ ″	r	″	″				″	
20. 49. 46	7. 21. 25·8	15. 30·46	0·784	7·06 + ·224 δ r	+ 7·86 = − ·2284 n	+ ·6445 δ R.A.	− ·7155 δ N.P.D.	− ·0342 δ t	− δ R	+ 1·224 δ r
50. 1	21. 40·8	29·95	0·843	7·59 + ·241	7·84 = − ·2284 n	38	62	42		1·241
50. 20	21. 59·8	29·30	0·828	7·45 + ·237	8·63 = − ·2283 n	30	70	41		1·237
50. 31	22. 10·8	28·93	0·971	8·74 + ·278	7·71 = − ·2283 n	25	75	41		1·278
50. 53	22. 32·8	28·18	0·905	8·14 + ·259	9·06 = − ·2284 n	16	85	34		1·259
51. 16	22. 55·8	27·42	1·122	10·10 + ·321	7·86 = − ·2284 n	06	95	18		1·321
51. 35	23. 14·8	26·78	1·128	10·15 + ·323	8·45 = − ·2283 n	·6398	·7204	39		1·323
51. 52	23. 31·8	26·21	1·297	11·67 + ·372	7·50 = − ·2283 n	90	12	37		1·372
52. 5	23. 44·8	25·77	1·290	11·61 + ·369	8·00 = − ·2283 n	84	18	35		1·369
52. 24	24. 3·8	25·14	1·223	11·01 + ·349	9·23 = − ·2283 n	76	26	31		1·349
52. 37	24. 16·8	24·80	1·370	12·33 + ·392	8·25 = − ·2283 n	71	31	29		1·392
52. 50	24. 29·8	24·27	1·495	13·46 + ·428	7·65 = − ·2284 n	65	38	28		1·428
53. 10	24. 49·8	23·61	1·520	13·68 + ·435	8·09 = − ·2282 n	56	47	35		1·435
53. 29	25. 8·8	22·96	1·670	15·03 + ·478	7·39 = − ·2282 n	47	56	28		1·478
53. 47	25. 26·8	22·38	1·630	14·67 + ·466	8·33 = − ·2282 n	39	64	34		1·466
53. 59	25. 38·8	21·96	1·725	15·53 + ·494	7·89 = − ·2282 n	34	70	32		1·494
54. 11	25. 50·8	21·57	1·805	16·25 + ·517	7·56 = − ·2282 n	29	75	32		1·517
54. 21	26. 0·8	21·24	1·770	15·93 + ·506	8·21 = − ·2282 n	24	80	31		1·506
54. 36	26. 15·8	20·76	1·805	16·25 + ·517	8·37 = − ·2281 n	18	86	31		1·517
54. 50	26. 29·8	20·31	1·942	17·48 + ·555	7·59 = − ·2281 n	11	93	30		1·555
55. 45	27. 24·8	18·49	2·058	18·53 + ·589	8·36 = − ·2281 n	·6287	·7317	29		1·589
56. 2	27. 41·8	17·95	2·100	18·90 + ·601	8·53 = − ·2281 n	79	25	14		1·601
56. 13	27. 52·8	17·60	2·135	19·22 + ·611	8·56 = − ·2281 n	74	30	17		1·611
56. 29	28. 8·8	17·09	2·165	19·49 + ·619	8·80 = − ·2280 n	67	37	21		1·619
20. 56. 40	7. 28. 19·8	15. 16·74	2·255	20·30 + ·645 δ r	+ 8·34 = − ·2279 n	+ ·6262 δ R.A.	− ·7342 δ N.P.D.	− ·0324 δ t	− δ R	+ 1·645 δ r

TABLE B. EQUATIONS of DISTANCE of CENTERS (*concluded*).

Recorded Time by Equatorial Clock.	Greenwich Sidereal Time.	Tabular Distance of Centers.	Micrometer Measures.	Inferred Distance of Near Limbs.	Resulting Equations.					
h m s	h m s	′ ″	r	″	″			″		
20. 56. 55	7. 28. 34·8	15. 16·24	2·348	21·14 + ·672 δ r	+ 8·00 = − ·2279 n	+ ·6255 δ R.A.	− ·7349 δ N.P.D.	− ·0312 δ t	− δ R	+ 1·672 δ r
57. 38	29. 17·8	14·84	2·598	23·39 + ·742	7·15 = − ·2279 n	36	69	24		1·742
57. 58	29. 37·8	14·21	2·505	22·55 + ·716	8·62 = − ·2278 n	26	78	16		1·716
58. 14	29. 53·8	13·70	2·740	24·66 + ·784	7·02 = − ·2278 n	19	85	16		1·784
58. 29	30. 8·8	13·22	2·658	23·93 + ·759	8·23 = − ·2277 n	12	92	15		1·759
58. 44	30. 23·8	12·74	2·748	24·74 + ·785	7·90 = − ·2277 n	05	99	15		1·785
58. 57	30. 36·8	12·33	2·821	25·39 + ·807	7·66 = − ·2276 n	·6199	·7405	20		1·807
59. 12	30. 51·8	11·85	2·880	25·93 + ·824	7·60 = − ·2277 n	93	11	05		1·824
59. 24	31. 3·8	11·49	2·965	26·70 + ·848	7·19 = − ·2276 n	87	17	19		1·848
59. 32	31. 11·8	11·23	3·000	27·01 + ·858	7·14 = − ·2275 n	83	21	13		1·858
59. 47	31. 26·8	10·75	3·270	29·44 + ·935	5·19 = − ·2275 n	76	28	19		1·935
20. 59. 57	31. 36·8	10·44	2·989	26·91 + ·855	8·03 = − ·2275 n	71	33	17		1·855
21. 0. 8	31. 47·8	10·09	3·055	27·50 + ·874	7·79 = − ·2275 n	66	38	15		1·874
0. 30	32. 9·8	9·40	3·220	28·97 + ·921	7·01 = − ·2274 n	56	47	10		1·921
0. 40	32. 19·8	9·08	3·097	27·88 + ·885	8·42 = − ·2274 n	51	51	15		1·885
0. 54	32. 33·8	8·64	3·330	29·98 + ·952	6·76 = − ·2274 n	45	58	02		1·952
1. 12	32. 51·8	8·08	3·320	29·89 + ·950	7·41 = − ·2272 n	36	66	09		1·950
1. 28	33. 7·8	7·57	3·335	30·02 + ·954	7·79 = − ·2273 n	29	73	·0314		1·954
1. 46	33. 25·8	7·03	3·420	30·79 + ·978	7·56 = − ·2272 n	21	81	·0293		1·978
2. 29	34. 8·8	5·71	3·620	32·59 + 1·035	7·08 = − ·2271 n	·6100	·7501	·0304		2·035
2. 51	34. 30·8	5·03	3·512	31·62 + 1·004	8·73 = − ·2270 n	·6089	11	05		2·004
3. 6	34. 45·8	4·56	3·670	33·04 + 1·050	7·78 = − ·2270 n	82	18	06		2·050
21. 3. 21	7. 35. 0·8	15. 4·09	3·672	33·06 + 1·050 δ r	+ 8·23 = − ·2270 n	+ ·6074 δ R.A.	− ·7526 δ N.P.D.	− ·0306 δ t	− δ R	+ 2·050 δ r
				Mean . .	+ 7·88 = − ·2279 n	+ ·6264 δ R.A.	− ·7338 δ N.P.D.	− ·0322 δ t	− δ R	+ 1·6472 δ r

TABLE C. EQUATIONS of DISTANCE of CENTERS from MR. NICHOL'S OBSERVATIONS near INTERNAL CONTACT with the $4\frac{1}{2}$-inch EQUATORIAL. Assumed Longitude $10^h. 31^m. 27^s.3$ W.

Recorded Time by Solar Chronometer C.	Greenwich Sidereal Time.	Tabular Distance of Centers.	Micrometer Measures.	Inferred Distance of Near Limbs.	Resulting Equation.	Inferred Greenwich Sidereal Time of Internal Contact.	Weight.
h m s	h m s	′ ″	r	″	″ ″	h m s s	
3. 37. 49	7. 11. 56·9	15. 50·46	4·105	13·95 + ·446 δr	+8·87 = −·2281 n + ·6679 δ R.A. − ·6897 δ N.P.D. − ·0364 δt − δR + ·554 δr	7. 18. 29·8 + 12·30 δr	4
38. 2	12. 9·9	49·99	4·016	13·11 + ·418	8·50 = −·2281 n + 74 ·6903 63 ·582	18. 19·3 + 11·60	4
38. 38	12. 46·0	48·69	3·857	11·75 + ·374	8·44 = −·2282 n + 58 19 62 ·626	18. 17·5 + 10·39	5
39. 2	13. 10·1	47·82	3·784	11·18 + ·356	8·74 = −·2282 n + 50 30 61 ·644	18. 26·1 + 9·89	5
39. 31	13. 39·1	46·78	3·515	9·29 + ·298	7·89 = −·2282 n + 38 43 53 ·702	18. 2·1 + 8·25	5
39. 50	13. 58·2	46·10	3·439	8·80 + ·280	8·08 = −·2282 n + 31 51 53 ·720	18. 7·3 + 7·81	6
40. 5	14. 13·2	45·55	3·355	8·30 + ·265	8·13 = −·2282 n + 25 58 59 ·726	18. 8·8 + 7·36	6
40. 27	14. 35·3	44·77	3·286	7·90 + ·252	8·51 = −·2282 n + 16 68 44 ·748	18. 19·6 + 7·04	6
40. 42	14. 50·3	44·24	3·094	6·90 + ·220	8·04 = −·2282 n + 10 75 50 ·780	18. 6·2 + 6·10	6
40. 59	15. 7·4	43·64	3·028	6·54 + ·210	8·28 = −·2282 n + ·6603 83 56 ·790	18. 13·1 + 5·84	7
41. 18	15. 26·4	42·96	2·756	5·29 + ·168	7·71 = −·2283 n + ·6595 91 52 ·832	17. 56·9 + 4·72	7
41. 35	15. 43·5	42·35	2·723	5·15 + ·164	8·18 = −·2284 n + 88 99 49 ·836	18. 10·2 + 4·59	8
41. 48	15. 56·5	41·89	2·578	4·57 + ·146	8·07 = −·2283 n + 83 ·7005 55 ·854	18. 6·8 + 4·09	8
42. 0	16. 8·5	41·46	2·474	4·18 + ·132	8·10 = −·2283 n + 78 10 48 ·868	18. 7·9 + 3·73	8
42. 11	16. 19·6	41·07	2·332	3·68 + ·117	7·99 = −·2283 n + 73 15 47 ·880	18. 4·8 + 3·28	9
42. 21	16. 29·6	40·73	2·253	3·41 + ·112	8·06 = −·2283 n + 69 20 54 ·888	18. 6·8 + 3·05	9
3. 42. 31	7. 16. 39·6	15. 40·38	2·156	3·11 + ·100 δr	+8·11 = −·2283 n + ·6565 δ R.A. − ·7025 δ N.P.D. − ·0354 δt − δR + ·900 δr	7. 18. 8·2 + 2·78 δr	9
				Mean with weights	8·17 = −·2283 n + ·6605 δ R.A. − ·6980 δ N.P.D. − ·0353 δt − δR + ·7866 δr	7. 18. 10·0 + 5·93 δr	
					″ ″		
3. 45. 56	7. 20. 5·2	15. 33·23	0·312	4·03 + ·128 δr	+8·12 = −·2283 n + ·6479 δ R.A. − ·7117 δ N.P.D. − ·0346 δt − δR + 1·128 δr		
46. 20	20. 29·2	32·41	0·443	5·72 + ·182	7·25 = −·2283 n + 69 29 31 ·182		
46. 44	20. 53·3	31·57	0·522	6·74 + ·214	7·07 = −·2284 n + 59 39 44 ·214		
47. 9	21. 18·4	30·71	0·552	7·13 + ·226	7·54 = −·2284 n + 48 51 35 ·226		
3. 47. 21	7. 21. 30·4	15. 30·30	0·562	7·26 + ·230 δr	+7·82 = −·2284 n + ·6443 δ R.A. − ·7157 δ N.P.D. − ·0342 δt − δR + 1·230 δr		

TABLE C. EQUATIONS of DISTANCE of CENTERS from MR. NICHOL'S OBSERVATIONS—*concluded.*

Recorded Time by Solar Chronometer C.	Greenwich Sidereal Time.	Tabular Distance of Centers.	Micrometer Measures.	Inferred Distance of Near Limbs.	Resulting Equation.				
h m s	h m s	′ ″	r	″	″			″	
3. 47. 41	7. 21. 50·4	15. 29·62	0·655	8·46 + ·269 δ r	+ 7·30 = − ·2283 n	+ ·6434 δ R. A.	− ·7166 δ N. P. D.	− ·0341 δ t − δ R	+ 1·269 δ r
48. 2	22. 11·5	28·91	0·715	9·23 + ·293	7·24 = − ·2283 n	+ 25	75	41	·293
48. 7	22. 16·5	28·74	0·770	9·94 + ·316	6·70 = − ·2284 n	+ 23	77	40	·316
48. 38	22. 47·6	27·68	0·840	10·85 + ·344	6·85 = − ·2283 n	+ 09	·7192	39	·344
48. 55	23. 4·6	27·12	0·880	11·36 + ·361	6·90 = − ·2283 n	+ ·6402	·7200	39	·361
49. 1	23. 10·7	26·90	0·910	11·75 + ·373	6·73 = − ·2284 n	+ ·6399	02	39	·373
50. 5	24. 14·8	24·79	1·015	13·11 + ·416	7·48 = − ·2283 n	+ 72	31	29	·416
50. 38	24. 47·9	23·67	1·140	14·72 + ·467	6·99 = − ·2282 n	+ ·6357	46	35	·467
50. 56	25. 6·0	23·05	1·194	15·42 + ·490	6·91 = − ·2282 n	+ 49	54	28	·490
52. 23	26. 33·2	20·19	1·358	17·54 + ·557	7·65 = − ·2281 n	+ 10	·7294	30	·557
52. 43	26. 53·3	19·53	1·408	18·18 + ·577	7·67 = − ·2281 n	+ ·6301	·7303	16	·577
53. 7	27. 17·3	18·75	1·482	19·14 + ·608	7·49 = − ·2280 n	+ ·6290	14	23	·608
53. 19	27. 29·4	18·36	1·521	19·64 + ·623	7·38 = − ·2280 n	+ 85	19	31	·623
53. 30	27. 40·4	18·00	1·568	20·25 + ·643	7·13 = − ·2280 n	+ 80	25	14	·643
53. 53	28. 3·5	17·26	1·602	20·69 + ·657	7·43 = − ·2280 n	+ 69	35	20	·657
54. 17	28. 27·5	16·47	1·611	20·80 + ·660	8·11 = − ·2279 n	+ 59	46	26	·660
54. 33	28. 43·6	15·96	1·750	22·60 + ·718	6·82 = − ·2279 n	+ 51	53	18	·718
54. 47	28. 57·6	15·49	1·792	23·14 + ·734	6·75 = − ·2278 n	+ 45	60	31	·734
55. 11	29. 21·7	14·79	1·745	22·53 + ·715	8·13 = − ·2278 n	+ 34	70	10	·715
55. 26	29. 36·7	14·25	1·821	23·51 + ·746	7·62 = − ·2278 n	+ 27	77	23	·746
55. 36	29. 46·7	13·92	1·851	23·90 + ·759	7·56 = − ·2278 n	+ 22	82	16	·759
55. 56	30. 6·8	13·28	1·823	23·54 + ·747	8·56 = − ·2277 n	+ ·6213	·7391	15	·747
56. 31	30. 41·9	12·15	2·042	26·37 + ·837	6·86 = − ·2278 n	+ ·6197	·7407	14	·837
57. 3	31. 14·0	11·15	2·135	27·57 + ·875	6·66 = − ·2275 n	+ 82	22	13	·875
57. 27	31. 38·0	10·40	2·148	27·74 + ·877	7·24 = − ·2275 n	+ 71	33	17	·877
57. 41	31. 52·1	9·96	2·276	29·39 + ·933	5·93 = − ·2274 n	+ 64	40	14	·933
3. 58. 8	7. 32. 19·2	15. 9·10	2·290	29·57 + ·939 δ r	+ 6·71 = − ·2274 n	+ ·6152 δ R. A.	− ·7451 δ N. P. D.	− ·0315 δ t − δ R	+ 1·939 δ r

By obtaining independent values of a revolution of the screws of the micrometers, the terms depending upon δr in these equations may be eliminated. With this view the distance of the Model from the stage was measured three times with a 100-feet measuring tape, the face of the model being placed exactly 800* feet from the front edge of the table on which the telescopes were laid. These projected a little over the edge, so that the distances of the object glasses from the Model may be taken at

798·4 feet for the 6-inch telescope.
799·6 „ 4½-inch „

The diameter of the disk of brass representing *Venus* was measured many times with three different scales by TROUGHTON and SIMMS, with the following results:—

2·8594 inches (by a scale of $\frac{1}{40}$).
2·8570 „ („ $\frac{1}{16}$).
2·8552 „ („ millimeters).

The mean 2·8572 inches.

The mean of a great many measures of the diameter of the model planet as seen in the telescopes gave the apparent values—

$6^{r}\cdot760 \pm \cdot020$ for the 6-inch instrument.
$4^{r}\cdot760 \pm \cdot010$ „ 4½-inch „

Consequently the values of one revolution of the screws, for the focus corresponding to the distance of the model, are—

$9''\cdot099 \pm \cdot030$ for the 6-inch.
$12''\cdot897 \pm \cdot027$ for the 4½-inch.

The focal lengths of the object glasses being, respectively, 89 and 69 inches, the values of one revolution of the screws for the solar focus are—

$9''\cdot184$ for the 6-inch.
$12''\cdot989$ for the 4½-inch.†

We have, therefore, the following values of the true semi-diameter of *Venus*:—

With the 6-inch instrument $32''\cdot18$.
„ 4½-inch „ $31''\cdot71$.

Hence the value of δr is—

$+ 0''\cdot76$ for the 6-inch.
$+ 0''\cdot29$ „ 4½-inch.

* Mr. Gay, with the 66-feet chain, afterwards made the distance 802 feet by a single measure. I doubt the accuracy of this.

† I afterwards found by transits of the double image of Polaris the values $12''\cdot99$ and $13''\cdot02$.

Colonel Tennant, by similar observations at Roorkee, made this quantity—

$+ 0''\cdot56$ for a 6-inch instrument;

and Captain Browne, at Mokattam—

$+ 0''\cdot62$, also for a 6-inch instrument.

The following final equations represent the whole of the observations made at Honolulu, omitting the micrometer measures of the distance of *limbs* with the $4\frac{1}{2}$-inch telescope, and the external contact observed with the spectroscope :—

Equation of Distance of Centers.	Observer.	Nature of Observation.
$8''\cdot72 = -''\cdot2251\,n + \cdot7024\,\delta\,\text{R.A.} - \cdot6481\,\delta\,\text{N.P.D.} - ''\cdot0392\,\delta t - \delta R - \cdot5592\,\delta r$	T	8 measures of *obtuse* cusps.
$7''\cdot99 = -''\cdot2283\,n + \cdot6589\,\delta\,\text{R.A.} - \cdot7002\,\delta\,\text{N.P.D.} - ''\cdot0353\,\delta t - \delta R + \cdot8384\,\delta r$	T	15 measures of *acute* cusps.
$8''\cdot17 = -''\cdot2283\,n + \cdot6605\,\delta\,\text{R.A.} - \cdot6980\,\delta\,\text{N.P.D.} - ''\cdot0353\,\delta t - \delta R + \cdot7866\,\delta r$	NI	17 measures of *acute* cusps.
$7''\cdot80 = -''\cdot2284\,n + \cdot6532\,\delta\,\text{R.A.} - \cdot7061\,\delta\,\text{N.P.D.} - ''\cdot0340\,\delta t - \delta R + 1\cdot0000\,\delta r$	T	Telescopic contact "passed."
$7''\cdot83 = -''\cdot2284\,n + \cdot6532\,\delta\,\text{R.A.} - \cdot7061\,\delta\,\text{N.P.D.} - ''\cdot0340\,\delta t - \delta R + 1\cdot0000\,\delta r$	NO	Telescopic contact.
$7''\cdot91 = -''\cdot2283\,n + \cdot6529\,\delta\,\text{R.A.} - \cdot7064\,\delta\,\text{N.P.D.} - ''\cdot0343\,\delta t - \delta R + 1\cdot0000\,\delta r$	FL	Telescopic contact "passed."
$7''\cdot88 = -''\cdot2279\,n + \cdot6264\,\delta\,\text{R.A.} - \cdot7338\,\delta\,\text{N.P.D.} - ''\cdot0322\,\delta t - \delta R + 1\cdot6742\,\delta r$	T	48 measures of *limbs*.

It is not without interest to compare the times of internal contact, as inferred from micrometric measurements, with the observed telescopic time. Before treating of the measures of the actual transit, I will exhibit the results obtained from the preliminary practice with the *model*. This apparatus is figured in Plate V., and needs but little description. The shaded portions were cut out of sheet brass; the curved edges, representing portions of the limb of the Sun and the periphery of the planet, were bevelled to diminish parallax; the planet, attached to a horizontal bar running on fixed wheels, was drawn towards the clock-work on the right by the action of the large weight, the motion being regulated by a pendulum.

The curvature of the Sun's edges was such as would be proper for a distance of 400 feet, but at Honolulu the model was erected at the distance of 800 feet, the planet being double the diameter shown in the plate. Sunlight was reflected into the telescopes, through the triangular opening, by means of a mirror mounted on another tripod stand, worked by an assistant, who knew perfectly well when it was properly adjusted by the brilliant light reflected

back to him by the glasses of the telescopes. The intermittent character of the motion of the artificial planet was not perceptible in the telescopes. These, removed from their mountings, were laid on a table as near together as convenient, some eight or nine feet from the ground. A roofing of rushes protected them and the observers from the direct rays of the Sun. The land between was flat and grassy.

The exact dimensions of the important parts of the model were as follows:

Length of each chord of the Sun's limb	4·99 inches.
Radius of curvature of ditto	24·47 ,,
Length of the base of the triangular opening	8·46 ,,
Height of ditto	2·94 ,,
Diameter of the planet (mean)	2·857 ,,
Length of the chord on the planet joining the two points that touch the limb of the Sun at the internal contacts ...	1·455 ,,

When the planet was set back horizontally exactly one inch from the position of perfect internal contact at ingress, the distance of the cusps was 2·250 inches.

The horizontal movement of the planet was one inch in $270^{s}\cdot3$ mean solar seconds.

A mean-time chronometer was always used for the model practice.

The distance of the model from the object-glasses of the telescopes may be considered—

798·4 feet for the 6-inch instrument.
799·6 ,, 4½-inch ,,

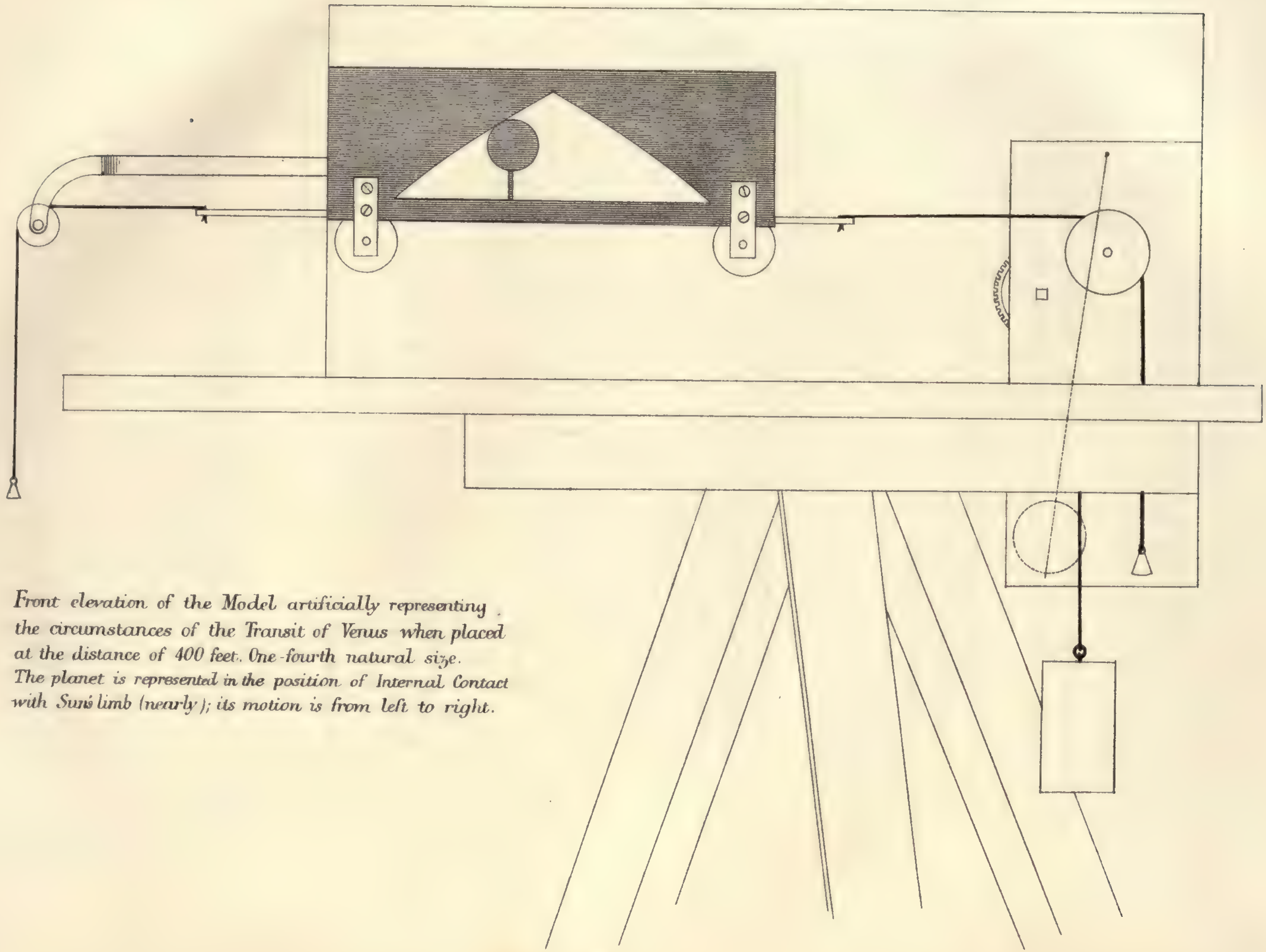
The practice with the model, at Honolulu as at Greenwich, demonstrated that there was no material difference between the different observers' appreciation of the exact moment of contact, no matter what telescopes were employed, provided the power was 100 or more. By suitable experiments it was found that the internal contact observed with the telescope was within a small fraction of a second of time of true mechanical contact.

As regards the instant of internal contact the appearances of the model bore no resemblance to the phenomena of the actual transit of Venus. The comparisons of the various observers at the model therefore possess no interest.

It is different, however, with the micrometer measures; the circumstances of which, as far as the eye could judge, were a perfect imitation of the actual ingress of *Venus*.

The daily micrometer practice on the model was a serious rehearsal of what was to be done during the actual transit; and, the records being

Transit of Venus 1874 Dec. 8.



Front elevation of the Model artificially representing the circumstances of the Transit of Venus when placed at the distance of 400 feet. One-fourth natural size. The planet is represented in the position of Internal Contact with Sun's limb (nearly); its motion is from left to right.

To face page 56.

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preserved, I have since reduced the measures of cusps, by means of the data given above, to see how they agreed with the true contact. The time of internal contact was deduced from a cusp measure in the following manner:—

The measurements of the model in inches were converted into their equivalents in revolutions of the micrometer, by taking the diameter of the planet as on page 54.

The small quantity by which the limb of *Venus* was outside the limb of the Sun, measured on the line of centers, was found from the equation given on page 47, and a table was then formed giving the distance of cusps corresponding to every ten seconds of time from true contact. The interval of time between the measure and true contact (called for convenience the reduction to contact), which rarely exceeded 250 seconds, was taken from the table for every cusp measure separately.

In order to test the accuracy of the data employed, more especially the assumed velocity of horizontal motion of the planet, the driving apparatus being of somewhat rude construction, I have separated the results of the larger and smaller cusp measures. The following table exhibits these results in sufficient detail. The telescopic contact was generally noted by one or two observers in addition to the observer who took the measures.

The table proves conclusively that the time of contact inferred from cusp measures is 3^s or 4^s too late for my own observations, and 4^s or 5^s too late for Mr. NICHOL's, the probable cause being that the extreme points of the cusps are not seen, although they appear so sharp.

COMPARISON of the TIME of INTERNAL CONTACT at INGRESS, derived from CUSP MEASURES of the MODEL with the OBSERVED TELESCOPIC CONTACTS.

(1.) Observer, TUPMAN.

Telescope.	By the larger Cusp Measures.			By the smaller Cusp Measures.			Telescopic Contact.		
	Mean of inferred Times of Contact.	No. of Obser-vations.	Mean Reduction to Contact.	Mean of inferred Times of Contact.	No. of Obser-vations.	Mean Reduction to Contact.	Mean of observed Contacts.	No. of Obser-vations.	Extreme Discord-ance from Mean.
	s		s	s		s	s		s
6-inch	45·0	5	162	42·2	4	63	31·5	2	0·2
,,	50·0	6	198	42·8	5	72	33·5	2	0·5
,,	59·0	2	208	57·0	2	110	58·0	1	..
,,	14·6	5	155	11·2	4	55	9·0	1	..

Telescope.	By the larger Cusp Measures.			By the smaller Cusp Measures.			Telescopic Contact.		
	Mean of inferred Times of Contact.	No. of Obser-vations.	Mean Reduction to Contact.	Mean of inferred Times of Contact.	No. of Obser-vations.	Mean Reduction to Contact.	Mean of observed Contacts.	No. of Obser-vations.	Extreme Discord-ance from Mean.
	s		s	s		s	s		s
6-inch	12·7	8	192	8·5	6	72	3·0	2	0·5
,,	57·0	6	181	53·5	6	74	49·2	2	0·3
,,	24·5	10	153	26·0	4	43	19·7	2	0·2
,,	35·4	5	121	30·6	5	50	31·0	2	0·5
,,	35·0	5	92	30·0	5	34	31·0	1	..
,,	5·2	5	82	4·0	5	33	3·0	1	..
4½-inch	4·0	5	101	4·0	4	46	1·2	2	0·3
,,	41·2	4	106	44·2	3	71	40·2	3	0·8
,,	3·0	4	57	4·0	3	24	1·7	3	0·3
,,	4·7	3	80	8·5	2	30	5·5	1	..
,,	27·8	5	79	28·6	5	37	25·2	2	0·3
Mean.	27·9	..	131	26·3	..	54	22·8	..	0·4

(2.) Observer, NICHOL.

	s		s	s		s	s		s
6-inch	5·0	4	224	6·2	4	89	4·0	2	0·2
,,	46·0	3	129	41·0	3	65	33·5	2	0·5
,,	31·0	3	105	29·3	3	57	25·0	2	0·0
4½-inch	60·0	4	179	59·5	4	93	53·2	2	0·3
,,	54·0	5	143	59·8	5	81	52·2	2	0·2
,,	50·5	4	160	48·2	4	64	44·5	3	0·5
,,	23·3	3	127	21·1	3	66	19·8	3	0·3
,,	11·7	4	71	12·0	3	30	6·5	3	0·5
,,	17·0	3	129	19·7	3	69	12·5	1	..
,,	14·0	4	122	14·0	4	65	15·0	1	..
,,	53·2	4	96	49·0	3	39	45·0	1	..
,,	26·4	9	144	27·9	7	58	25·8	3	0·8
,,	33·2	9	128	33·4	7	52	29·5	2	0·0
,,	9·4	5	157	7·6	5	68	0·5	2	0·0
Mean.	31·0	..	137	30·6	..	64	26·2	..	0·3

Coming now to the actual transit, the time of contact may be inferred from each cusp-measure with great facility, since the local tabular distance of centers has been computed for each recorded time.

The inferred times are given in Tables B and C affected by a quantity depending on δr. Considering the internal contact only, we have the following means of the times from the cusp measures:—

	G. Sid. Time.		
Tupman	$7^h. 18^m. 4^s{\cdot}9$	$+ 4{\cdot}52\,\delta r$	where $\delta r = + 0''{\cdot}76$.
Nichol	$7^h. 18^m. 10^s{\cdot}0$	$+ 5{\cdot}93\,\delta r$	where $\delta r = + 0''{\cdot}29$.

Hence the corrected inferred times are—

Tupman............	$7^h. 18^m. 8^s\cdot 1$	G.S.T.
Nichol.............	$7^h. 18^m. 11^s\cdot 7$	

While the telescopic contact was certainly passed—

at $7^h. 18^m. 0^s.$ (Tupman and Noble).

These results are in perfect accordance with those obtained by Colonel TENNANT at Roorkee, who found the time of contact inferred from the cusp measures to be $10^s\cdot 2$ later than the telescopic time of contact.

I may remark here, that although these cusp measures appear to be very reliable, there is a very serious discrepancy between the observations at Honolulu and at Roorkee, amounting to 17 or 18 seconds of time on any reasonable assumption of the solar parallax.

I have thought it not worth while to make a similar comparison with the measures of *limbs*, the co-efficient of δr being very large.

REPORT OF MR. J. W. NICHOL.

The observation of external contact was taken by me with the Naylor 6-inch equatoreal telescope, with power of 145, and neutral tint glass.

Lieut. Oldham, R.N., took time for me, counting seconds aloud and making the entries in the note-book.

The limb of the Sun was very rugged.

The first time recorded was when I perceived a definite indentation on the upper limb of the Sun, and the contact must have occurred, from the size of the indentation, 30 seconds to a minute before that time.

I then changed places with Captain Tupman, and going to his 4½-inch equatoreal inserted the double-image micrometer eye-piece, the power of which was about 150. The planet was then accurately focussed, brought into the middle of the field, and the two images adjusted to equal intensity. Twelve observations for diameter were taken, when the planet appeared to be fully half way on the sun. The method of bisection was to place the two images so that they separated and joined alternately as nearly as possible to the same extent by the continued vibration of the air. By this time the cusps were approaching, and the phenomenon appeared almost the same as the model, except that the planet seemed somewhat brighter by contrast.

Seventeen observations of cusps were taken. The definition of the extremities of the cusps was as good as on an average day at the model, and I found no difficulty in just getting them to touch.

When the micrometer reading had diminished to $12^r.152$, knowing from previous model practice that I had more than a minute to spare before internal

contact, I took out the double-image eye-piece, and immediately inserted a negative eye-piece of power 130, furnished with a neutral tint sliding wedge. The telescope was slightly disturbed in doing so, but that did not prevent me from getting it re-adjusted and sharply focussed in 32 seconds after the last reading of the micrometer, when to my astonishment I saw a completion of light round the planet, perfectly distinct, and such as I should have said, from previous model practice, was immediately after contact. This is the time recorded. I remained looking at it for about two minutes, but could see no instantaneous phenomenon of contact, no black drop, nor anything resembling the model. I noticed that this light did not appear to thicken as I should have expected for a considerable time after that recorded; but as I considered, from my previous experience (with the *model*), that the contact had occurred, and was unable to get, accurately, any further change until the planet was visibly on the Sun, I cannot say that the time as noted is at all satisfactory.

The double-image micrometer was then replaced and 33 limb and 20 diameter observations taken. These were to my mind as good as any I could have taken on an average day at the model.

The planet appeared circular, although the edge vibrated considerably.

$20^h. 19^m. 23^s.$ External contact first perceived. Time by Equatoreal Clock [*see* page 46].

$4\frac{1}{2}$-inch equatoreal—double-image micrometer measures of the diameter of *Venus*.*

Micrometer Readings.	
r	r
5·091	14·889
5·088	14·905
5·062	14·881
5·080	14·911
5·155	14·909
5·125	14·860

$4\frac{1}{2}$-inch equatoreal—double-image micrometer measures of cusps. Time counted from chronometer C by Lieutenant Oldham, R.N.

h m s	Micrometer Readings. r	h m s	Micrometer Readings. r
3. 37. 49	14·101	3. 39. 2	13·780
38. 2	14·012	39. 31	13·511
38. 38	13·853	39. 50	13·435

* The reading of the micrometer for coincidence of the optic axes of the two halves of the divided lens was approximately $10^r·0$. Readings greater and less than $10^r·0$ indicate that the movable half-lens was on alternate sides of the fixed half-lens.

h m s	Micrometer Readings. r	h m s	Micrometer Readings. r
3. 40. 5	13·351	3. 41. 48	12·574
40. 27	13·282	42. 00	12·470
40. 42	13·090	42. 11	12·328
40. 59	13·024	42. 21	12·249
41. 18	12·752	42. 31	12·152
41. 35	12·719		

3h. 43m. 3s. Internal contact. Time by chronometer C. Double-image micrometer measures of limbs.

h m s	Micrometer Readings. r	h m s	Micrometer Readings. r
3. 45. 56	10·312	3. 53. 7	11·482
46. 20	10·443	53. 19	11·521
46. 44	10·522	53. 30	11·568
47. 9	10·552	53. 53	11·602
47. 21	10·562	54. 17	11·611
47. 41	10·655	54. 33	11·750
48. 2	10·715	54. 47	11·792
48. 7	10·770	55. 11	11·745
48. 38	10·840	55. 26	11·821
48. 55	10·880	55. 36	11·851
49. 1	10·910	55. 56	11·823
50. 5	11·015	56. 31	12·042
50. 38	11·140	57. 3	12·135
50. 56	11·194	57. 27	12·148
52. 23	11·358	57. 41	12·276
52. 43	11·408	58. 8	12·290

Double-image micrometer measures of the diameter of *Venus*—

Micrometer Readings. r	r	r
14·902	5·179	14·928
·850	·143	·818
·845	·135	
·831	·078	
·880	·130	
·899	·130	
·859	·162	
·851	·090	
	·142	
	·143	

Subsequent remarks, December 8, 8 p.m.

From what I learn from others who continued to observe during the whole phenomenon with the same eye-piece, I feel inclined to think that the thin line of light which I observed on changing the eye-pieces must have been due to light from the Sun's corona. No light of the kind was visible in the double-image micrometer, and I regret that it was changed, since otherwise, I think, a very good time of contact would have been obtained by it.

J. W. NICHOL.

Mr. Nichol's chronometer (*see* following comparisons) was $7^{m}. 55^{s}{\cdot}17$ *fast* on local mean time.

COMPARISONS of the SOLAR CHRONOMETER C with the TRANSIT CLOCK, and inferred ERROR of C on LOCAL MEAN TIME, on 1874, December 8.

Time by Transit Clock.	Honolulu Mean Time.	Corresponding Time by Chronometer C.	Chronometer C *Fast* on Local Mean Time.	Observer.
h m s	h m s	h m s	m s	
19. 26. 23·00	2. 16. 9·82	2. 24. 5·00	7. 55·18	Ni
19. 29. 24·00	2. 19. 10·33	2. 27. 5·50	7. 55·17	Ni
21. 57. 35·00	4. 46. 57·09	4. 54. 52·50	7. 55·41	T
22. 16. 6·00	5. 5. 25·07	5. 13. 20·50	7. 55·43	T

REPORT OF LIEUT. E. J. W. NOBLE, R.M.A.

The instrument I used was the Dollond telescope of $3\frac{1}{2}$ inches aperture and 57 inches focal length, with a solar diagonal prismatic eye-piece giving rectangular reflection, a power of 139, and the darkest neutral tint glass. The instrument, protected from the N.E. trade by a "bell" tent, was mounted close to the door of the altazimuth hut, so that I could distinctly hear the counting of the time-keeper, Lieut. Shakspear, R.N., of H.M.S. *Scout*, with whom I had practised, and of the accuracy of whose counting I was quite convinced.

As the time for external contact approached, I observed a slight notch on the vertex of the Sun. At $20^{h}. 17^{m}. 11^{s}.$ I was fully satisfied that Venus had entered on the Sun, and I estimated that the external contact had taken place $2^{m}. 30^{s}.$ before [or at about $20^{h}. 14^{m}. 40^{s}.$].

I then left the telescope, and took only casual glances as the planet advanced on the Sun till within about 10 minutes of the time of internal contact, when I kept the instrument pointed on the Sun's limb.

Whilst thus watching I was astonished to see, most distinctly, the disc of the planet complete, and immediately asked Lieut. Shakspear what time remained before contact. He said "a little over five minutes."

There was an understanding between us about the Nautical Almanac time being two minutes in error from the observed external contact.

The Sun's limb was very steady, and the planet was quite circular, with a bluish rim round it.

The first time recorded at internal contact ($20^h. 45^m. 43^s.$ by the altazimuth clock) is that when the cusps had apparently joined.

There was no black drop, no ligament, but a rough dark shade, which gradually faded off to a thin tint, corresponding to the phenomenon I had observed in the model. This—instead of being nearly instantaneous, as the model generally showed—extended over some 20 seconds.

The thin tint is that recorded as the second time ($20^h. 46^m. 2^s.$) at internal contact.

At the third recorded time ($20^h. 46 \ . 22^s.$) there was a broad band of light between Venus and the Sun's limb, and contact was long past.

The second recorded time ($20^h. 46^m. 2^s.$) by the clock is that which I consider as the time of contact, and am certain it could not have been later than this.

E. J. W. NOBLE.

The altazimuth clock used for Lieut. Noble's observations (*see* Table VI.) was 30·90 seconds *slow* on Honolulu sidereal time at the time of internal contact. Assuming the longitude $10^h. 31^m. 27^s{\cdot}3$ west, we have the following equation corresponding to his recorded time, $20^h. 46^m. 2^s$.

Gr. Sid. Time.
$7^h. 18^m. 0^s{\cdot}2$, $\qquad 7''{\cdot}83 = -{\cdot}2284\, n + {\cdot}6532\, \delta\, \text{R.A.} - {\cdot}7061\, \delta\, \text{N.P.D.} - ''{\cdot}0340\, \delta t - \delta R + \delta r$

MR. FLITNER'S OBSERVATION OF THE INGRESS OF *Venus*, 1874, DECEMBER 8, at WAIAKIKI, NEAR HONOLULU.

Mr. Flitner kindly communicated to me, orally, the following circumstances, which I committed to writing in his presence.

He observed the ingress of Venus, from the garden of Captain Smith's house at Waiakiki, with an achromatic of $2\frac{1}{4}$ or $2\frac{1}{2}$ inches aperture on an ordinary "pillar and claw" stand, furnished with a negative eye-piece of power of 80 to 100 and a dark glass which screwed on at the eye-end for viewing the sun directly. He used a pocket chronometer of large size and showing seconds, which he compared with his standard clock at Honolulu on

the morning of December 8, before going to Waiakiki. Captain Smith had taken with him the box chronometer, *Frodsham* 6551 (which he afterwards lent to me for the longitude work). Mr. Flitner compared his pocket chronometer with No. 6551 as below :—

	h m s		h m s		h m s
No. 6551	2. 54. 0·0	No. 6551	3. 17. 0·0	No. 6551	3. 45. 0·0
Pocket	2. 53. 22·4	Pocket	3. 16. 22·0	Pocket	3. 44. 22·4

The external contact was first perceived at $3^h. 10^m. 6^s{\cdot}5$ by the pocket chronometer. "Internal contact was complete and clear sunlight between the limbs" at $3^h. 35^m. 50^s{\cdot}0$.

I copied the above figures from the original records on small scraps of paper which Mr. Flitner brought with him.

For the absolute error of No. 6551 on the afternoon of December 8 we have the following connections :—

	h m s	
December 8, 11^h. a.m.		
Flitner's clock	10. 52. 0·0	Observer, Flitner.
No. 6551	10. 52. 32·5	
December 9, near noon.		
Flitner's clock	11. 45. 0·0	,, ,,
No. 6551	11. 45. 32·8	
Transit clock at Apua ...	17. 23. 51·0	,, Nichol.
No. 6551	0. 10. 30·0	
Transit clock at Apua ...	19. 4. 40·0	,, ,,
Chronometer (R)	1. 50. 22·5	
Flitner's clock	2. 35. 0·00	,, ,,
Chronometer (R)	2. 34. 52·85	
Transit clock at Apua ...	21. 0. 1·0	,, ,,
Chronometer (R)	3. 45. 25·0	

Mr. Flitner was in the habit of determining the error and rate of his standard clock by observations of the Sun with a transit instrument, carrying to his observatory, one-third of a mile distant, a half-second's chronometer. He considered that his clock had a gaining rate of $0^s{\cdot}09$. The clock itself was a fine specimen of Molyneux's work, with mercurial pendulum, and was solidly mounted on the wall of Mr. Flitner's house, where it kept a fairly steady rate all the year round, being regulated to mean solar time. From the above comparisons, accepting $0^s{\cdot}09$ as the gaining rate of the clock, the error of No. 6551 is deduced as follows :—

December 8, $10^h. 52^m$. a.m., No. 6551 *fast* $27^s{\cdot}47$
December 9, $11^h. 45^m$. a.m., ,, ,, $27^s{\cdot}56$ } Hence the rate $-0^s{\cdot}14$.

Mr. Flitner's pocket chronometer was therefore $10^s \cdot 3$ *slow* on APUA mean time, and the APUA mean time of his observation of internal contact is $3^h. 10^m. 16^s \cdot 8$.

It only remains to state that Waiakiki is a village about 3 miles S.E. of Honolulu. In computing the following final equation, which represents Mr. Flitner's observation in the same terms as all the others, I have taken his position as—

Latitude $21°. 16'. 0''$ N.; Longitude $10^h. 31^m. 19^s \cdot 3$ W.

whence the final equation,

$$7'' \cdot 91 = -0'' \cdot 2283\, n + \cdot 6529\, \delta\, \text{R.A.} - \cdot 7064\, \delta\, \text{N.P.D.} - 0'' \cdot 0343\, \delta\, t - \delta\, R + \delta\, r.$$

G. L. TUPMAN.

MERIDIONAL AND ALTAZIMUTH OBSERVATIONS

AT

HONOLULU,

IN TABULAR ARRANGEMENT.

TABLE I.—LEVEL ERROR of the TRANSIT INSTRUMENT at HONOLULU, determined by SPIRIT LEVEL.

[The sign + indicates that the East Pivot is low.]

Day.	Observer.	Sidereal Time of Level Determination.	Position of Head of Micrometer Screw.	Level Error corrected for inequality of Pivots.
1874.		h m		″
October 2	T	21. 5	W	+ 5·62
	T	22. 10	W	+ 6·11
	T	22. 14	W	+ 6·28
	T	22. 18	E	+ 5·86
	T	22. 23	E	+ 6·15
	T	23. 22	E	+ 6·08
3	T	19. 59	E	+ 5·37
	T	20. 2	E	+ 5·14
	T	20. 16	W	+ 5·17
	T	21. 19	E	+ 5·56
	NO	0. 49	E	+ 5·89
	NO	1. 38	W	+ 5·37
	NO	1. 55	W	+ 7·09
4	R	0. 50	W	+ 4·80
	R	1. 30	E	+ 6·41
	R	2. 15	E	+ 6·47
October 5, 3^h. Altered Azimuth and Level Screws.				
5	R	19. 36	E	+ 2·23
	R	20. 5	W	+ 1·58
	R	21. 10	W	+ 2·36
	NO	0. 20	W	+ 2·65
	NO	0. 53	E	+ 3·08
	NO	1. 25	E	+ 1·71
	T	20. 6	W	+ 0·73
	T	20. 45	W	+ 1·02
	T	20. 50	E	+ 1·75
	T	21. 36	E	+ 1·81
	H	0. 45	W	+ 1·51
	R	1. 30	W	+ 2·56
	R	2. 35	W	+ 3·32
7	NI	20. 10	W	+ 0·99
	NI	20. 43	W	+ 1·45
	NI	21. 3	W	+ 1·51
	NI	21. 45	W	+ 2·21
	R	22. 35	W	+ 1·67
	R	0. 10	W	+ 2·44
1874.		h m		″
October 8	T	22. 32	W	+ 1·61
	T	23. 36	W	+ 2·72
	T	23. 40	W	+ 1·97
	H	0. 45	W	+ 2·46
	R	1. 40	W	+ 3·47
	NO	5. 35	W	+ 1·16
	NO	6. 20	W	+ 1·26
9	NO	22. 35	W	+ 0·70
	NO	23. 25	W	+ 1·67
	T	1. 20	W	+ 2·33
	T	2. 35	W	+ 3·02
	R	5. 35	W	+ 2·10
	R	6. 50	W	+ 3·57
11	NI	0. 28	E	+ 1·22
	NI	0. 55	E	+ 1·45
	R	6. 50	E	+ 2·11
	R	7. 10	E	+ 2·20
12	T	0. 54	E	+ 0·86
	T	1. 47	E	+ 0·21
14	T	0. 53	E	+ 0·18
	H	6. 0	E	+ 1·06
15	NO	23. 25	W	− 0·34
	NO	1. 20	W	+ 0·64
	T	6. 36	W	+ 1·02
16	R	0. 15	E	+ 0·21
	R	2. 5	E	− 3·80
17	T	19. 43	E	− 3·54
	T	20. 37	E	− 3·63
	NO	0. 10	E	− 3·05
	NO	1. 25	E	− 3·18
	R	5. 45	E	− 3·18
	R	7. 15	E	− 1·87
18	T	20. 34	E	− 3·31
	T	2. 15	E	− 2·66

Day.		Observer.	Sidereal Time of Level Determination.	Position of Head of Micrometer Screw.	Level Error corrected for inequality of Pivots.
1874.			h m		″
October	19	NO	21. 40	E	− 2·30
		T	1. 25	E	− 2·62
	20	R	21. 20	E	− 2·31
		R	22. 35	E	− 2·51
		NO	1. 25	E	− 2·02
	21	T	22. 20	E	− 2·54
		T	0. 0	E	− 2·24
		T	1. 25	W	− 2·19
		NO	6. 0	W	− 1·80
	22	NO	23. 37	W	− 3·36
		T	1. 42	W	− 2·19
		R	5. 35	W	− 2·45
		R	6. 55	W	− 1·57
	23	T	1. 0	W	− 2·19
		T	1. 28	W	− 1·57
	24	NO	1. 30	W	− 2·06
		R	5. 50	W	− 2·00
	25	NO	1. 25	E	− 2·44
		R	3. 10	E	− 2·64
	26	NO	3. 10	E	− 1·33
		NO	4. 15	E	− 1·36
		R	5. 30	E	− 1·36
		R	7. 20	E	− 1·14
	27	R	0. 55	E	− 0·84
		R	2. 40	E	− 1·27
		NO	4. 55	E	− 0·45
		NO	6. 1	E	− 0·71
	28	T	22. 38	E	− 1·59
		T	22. 58	W	− 1·70
	29	R	0. 55	E	− 1·89
		R	2. 40	E	− 1·40
	30	T	1. 25	E	− 0·84
		T	2. 40	E	− 1·33
November	2	T	23. 56	W	+ 0·12

Day.		Observer.	Sidereal Time of Level Determination.	Position of Head of Micrometer Screw.	Level Error corrected for inequality of Pivots.
1874.			h m		″
November	3	NO	0. 10	W	− 0·46
	4	R	5. 50	E	− 1·20
		R	7. 25	E	− 0·91
	5	R	0. 45	E	− 1·98
		R	2. 50	E	− 2·18
		NO	7. 0	E	− 0·45
	6	NO	0. 30	E	− 1·04
		NO	1. 0	E	− 0·81
		R	6. 0	E	− 0·52
		R	7. 55	E	− 1·27
	7	R	0. 45	W	− 1·47
		R	2. 6	W	− 1·02
		NO	7. 0	W	− 0·49
	8	T	1. 30	E	− 0·52
		R	6. 25	E	+ 0·20
		R	8. 25	E	− 0·19
	9	R	0. 50	E	− 0·68
		R	2. 30	E	− 0·97
		NO	6. 20	E	− 0·26
	10	NO	0. 30	W	+ 0·32
		NO	1. 55	W	+ 0·48
	11	R	0. 35	W	− 0·49
		R	2. 20	W	+ 0·19
	12	T	1. 29	W	0·0
		R	5. 50	W	+ 0·45
		R	8. 45	W	+ 3·09
	13	NO	0. 6	W	− 0·88
		NO	1. 25	W	+ 0·87
		T	7. 2	W	+ 1·56
		T	7. 59	W	+ 1·92
		T	8. 4	W	+ 1·89
	14	NO	23. 55	W	+ 0·16
		NO	1. 5	W	+ 1·46
		R	5. 55	W	+ 1·00

Day.	Observer.	Sidereal Time of Level Determination.	Position of Head of Micrometer Screw.	Level Error corrected for inequality of Pivots.
1874.		h m		″
November 15	NO	20. 40	W	− 0·36
	R	0. 55	W	+ 0·06
Some Cement, in a semi-fluid state, was poured under the Piers.				
16	T	6. 0	E	− 1·92
	T	22. 37	E	− 2·02
	R	0. 55	E	− 1·66
17	NO	0. 5	E	− 2·99
22	T	1. 42	W	− 3·66
	T	3. 25	W	− 2·97
	NO	6. 45	W	− 2·81
23	NO	0. 35	W	− 3·30
	NO	1. 50	W	− 2·91
23	T	4. 25	W	− 2·61
	R	6. 10	W	− 2·45
24	T	1. 39	W	− 3·46
25	R	0. 55	W	− 3·92
	R	1. 30	W	− 3·40
	T	13. 27	W	− 3·82
26	NO	0. 5	W	− 3·62
	NO	1. 40	W	− 2·91
	NO	7. 58	W	− 3·10
27	NO	1. 45	W	− 3·82
	NO	1. 50	W	− 3·30
	R	6. 30	W	− 3·07
	T	9. 17	W	− 2·06
	T	10. 15	W	− 2·09
28	T	1. 52	W	− 3·10
	NO	7. 50	W	− 3·40
	R	9. 20	W	− 2·71
	R	10. 20	W	− 1·18
29	R	0. 55	W	− 3·79
	T	10. 55	E	− 3·91
30	NO	1. 0	E	− 3.58
	R	6. 20	E	− 3·74

Day.	Observer.	Sidereal Time of Level Determination.	Position of Head of Micrometer Screw.	Level Error corrected for inequality of Pivots.
1874.		h m		″
December 1	T	1. 44	E	− 3·87
	T	3. 15	E	− 3·97
	NO	7. 10	E	− 3·84
	T	12. 20	E	− 3·32
2	R	5. 50	E	− 3·58
	T	12. 0	E	− 3·42
	T	1. 30	E	− 4·62
	NO	6. 5	E	− 4·04
4	NO	0. 50	E	− 3·81
	NO	1. 55	E	− 4·14
	R	5. 50	E	− 3·55
5	R	0. 45	E	− 3·94
	NO	7. 10	E	− 3·09
	[illegible]	12. 15	E	− 2·83
6	T	22. 20	W	− 4·08
	T	1. 43	W	− 3·46
7	NI	22. 30	W	− 4·44
	[illegible]	0. 45	W	− 3·72
	NO	4. 55	W	− 2·71
8	NO	0. 30	W	− 4·04
	NO	1. 30	W	− 3·13
	T	8. 7	W	− 2·84
	NI	15. 20	W	− 4·18
9	NO	0. 55	W	− 3·55
	R	5. 50	W	− 3·62
10	R	0. 45	W	− 4·05
	NO	5. 50	W	− 3·04
11	NO	1. 42	E	− 3·61
	[illegible]	4. 50	E	− 3·94
12	R	0. 30	E	− 3·03
13	T	1. 45	E	− 4·74
	R	5. 10	E	− 4·66
14	R	22. 53	E	− 4·43
	R	0. 55	E	− 4·43

Day.		Observer.	Sidereal Time of Level Determination.	Position of Head of Micrometer Screw.	Level Error corrected for inequality of Pivots.
1874.			h m		″
December	15	NO	1. 20	E	− 3·39
		R	5. 0	E	− 2·86
	16	R	23. 50	E	− 1·30
		R	1. 45	E	− 2·64
		NO	6. 20	E	− 2·38
		NI	13. 24	E	− 2·15
	17	NO	1. 0	E	− 2·86
		R	6. 25	E	− 1·92
		NI	13. 0	E	− 2·31
		NI	13. 25	E	− 2·54
	18	R	1. 0	E	− 2·31
		T	13. 31	W	− 2·48
	19	NO	2. 5	W	− 3·27
		NO	6. 25	W	− 0·79
	20	NO	3. 45	W	− 0·98
		NO	6. 25	W	− 0·33
	21	T	5. 20	W	− 0·88
		T	8. 0	W	− 0·01
		T	8. 10	W	− 0·04
	22	NO	6. 45	W	− 0·43
		T	13. 30	W	− 0·95
	23	NO	7. 50	E	− 0·74
	24	R	7. 5	E	− 1·46
	26	H	6. 55	W	− 1·99
	27	NO	5. 17	W	− 1·86
December 28, $17\frac{1}{2}^h$. Earthquake.					
	29	R	0. 15	E	− 1·82
		R	0. 15	E	− 2·18
		NO	5. 45	E	− 2·08
		T	13. 40	E	− 1·36
	30	NI	0. 57	E	− 2·47
		R	5. 50	E	− 2·18
		NO	13. 15	E	− 1·75

Day.		Observer.	Sidereal Time of Level Determination.	Position of Head of Micrometer Screw.	Level Error corrected for inequality of Pivots.
1874.			h m		″
December	31	R	0. 25	E	− 2·02
		T	13. 0	E	− 1·04
		T	13. 45	E	− 1·10
1875.					
January	1	NI	0. 39	E	− 2·41
		NO	6. 0	E	− 0·55
		NO	7. 0	E	− 0·68
		T	14. 20	E	− 0·87
		T	14. 48	E	− 0·65
	2	R	0. 52	E	− 1·82
		R	5. 55	E	− 0·68
		T	13. 50	E	− 0·16
	3	R	13. 5	E	− 0·09
		H	14. 15	E	+ 0·40
	4	R	0. 35	E	+ 0·00
		T	3. 48	E	− 0·29
		R	12. 20	E	+ 1·11
	5	R	5. 52	E	+ 0·20
	6	R	0. 42	E	− 1·14
		H	1. 0	W	− 2·52
		T	6. 35	W	− 0·46
		T	6. 35	W	− 0·52
		T	7. 10	W	− 0·18
		R	12. 20	W	− 0·10
	7	T	0. 40	W	− 2·03
		T	13. 23	W	+ 0·42
		T	14. 3	W	+ 0·26
	8	NI	0. 55	W	− 2·0
		R	1. 24	W	− 1·50
		H	3. 50	W	− 1·47
		T	13. 23	W	− 0·04
	9	T	7. 1	W	− 0·66
		R	13. 5	W	+ 0·55
		R	13. 55	W	+ 0·35
	10	T	0. 40	W	− 2·50
		R	6. 25	W	− 0·82

Day.	Observer.	Sidereal Time of Level Determination.	Position of Head of Micrometer Screw.	Level Error corrected for inequality of Pivots.
1875.		h m		″
January 10	T	13. 23	W	+ 0·03
	T	14. 20	W	+ 0·45
11	T	1. 15	W	− 1·15
	R	5. 58	W	+ 0·32
	T	13. 20	W	− 0·18
12	R	1. 20	W	− 1·15
	R	12. 45	W	− 0·40
13	T	0. 42	W	− 2·32
	R	12. 50	W	+ 0·16
	R	15. 0	W	+ 1·07
14	R	0. 5	W	− 2·16
	R	2. 50	W	− 0·20
	NI	14. 36	W	− 1·31
15	R	2. 25	W	− 0·82
	R	3. 36	W	− 0·10
	R	12. 55	W	− 1·24
16	T	1. 25	W	− 3·27
	T	1. 30	W	− 3·10
	R	3. 25	W	− 2·65
	R	6. 7	W	− 1·34
	NI	13. 0	W	− 1·44
	NI	13. 30	W	− 1·50
17	NI	0. 57	W	− 2·58
	NI	1. 35	W	− 2·84
	R	4. 30	W	− 1·47
	R	6. 0	W	− 1·53
18	NI	1. 7	E	− 2·51
	NI	1. 24	E	− 2·83
	R	5. 30	E	− 1·71
	R	6. 45	E	− 1·10
	NI	15. 28	E	− 1·30
19	T	1. 5	E	− 3·09
	T	1. 47	E	− 2·93
	T	6. 25	E	− 2·80
	T	6. 50	E	− 2·70
1875.		h m		″
January 20	T	1. 5	E	− 3·72
	R	6. 0	E	− 3·03
	R	8. 30	E	− 3·16
	T	15. 0	E	− 2·93
21	NI	1. 50	E	− 3·35
	T	7. 40	W	− 3·17
	T	7. 57	W	− 3·17
	T	8. 57	W	− 2·13
22	R	1. 7	W	− 3·85
	T	8. 0	W	− 3·01
	R	9. 40	W	− 2·78
	R	11. 30	W	− 1·77
23	NI	1. 50	W	− 3·49
	R	6. 25	W	− 2·39
	NO	10. 50	W	− 1·86
24	R	2. 25	W	− 3·53
	NO	6. 15	W	− 2·55
	R	11. 15	W	− 1·62
	R	12. 55	W	− 0·17
25	T	2. 0	W	− 3·10
	T	12. 25	W	− 2·03
	T	13. 20	W	− 1·44
	NO	15. 15	W	− 2·52
26	NI	2. 21	W	− 3·27
	NO	6. 50	W	− 1·83
	T	13. 0	E	− 2·34
	T	14. 15	E	− 2·67
	R	15. 20	E	− 1·92
27	NI	2. 28	E	− 3·12
	R	5. 55	E	− 2·70
	T	13. 5	W	− 2·45
	T	14. 13	W	− 1·55
	NO	15. 55	W	− 2·35
28	NI	2. 36	E	− 2·90
	NO	6. 33	E	− 2·15
	T	14. 55	W	− 2·03
	T	15. 15	W	− 1·73

Day.		Observer.	Sidereal Time of Level Determination.	Position of Head of Micrometer Screw.	Level Error corrected for inequality of Pivots.	Day.		Observer.	Sidereal Time of Level Determination.	Position of Head of Micrometer Screw.	Level Error corrected for inequality of Pivots.
1875.			h m		″	1875.			h m		″
January	29	NI	2. 23	W	− 3·40	February	3	NI	3. 1	E	− 3·97
		R	5. 55	W	− 1·90			NO	7. 5	E	− 3·81
		T	14. 55	W	− 1·24		6	T	2. 48	W	− 3·33
		T	15. 32	W	− 1·24			NO	7. 26	W	− 3·1(?)
	30	NI	2. 35	E	− 2·38		7	NI	3. 10	W	− 2·84
		NO	6. 22	E	− 0·87			T	7. 55	W	− 1·41
		T	15. 32	E	− 1·59			R	12. 0	W	− 0·9(?)
		T	16. 15	E	− 1·25			NI	15. 40	W	− 0·59
	31	T	2. 38	E	− 2·60			NI	15. 55	W	− 0·69
		R	6. 5	E	− 1·46		8	T	3. 17	W	− 4·64
		R	15. 22	E	− 0·94			R	8. 30	W	− 3·5(?)
		R	16. 55	E	− 2·31			NI	12. 0	W	− 2·0(?)
February	1	NI	2. 24	E	− 3·58			NO	15. 40	W	− 0·88
		R	6. 4	E	− 3·29		9	R	3. 19	W	− 3·69
	2	NI	2. 52	E	− 4·56			NI	9. 30	W	− 1·44
		NO	8. 5	E	− 3·52			T	13. 5	W	− 1·24
								T	15. 55	W	− 0·80

TABLE II.—COLLIMATION of the TRANSIT INSTRUMENT at HONOLULU, determined by OBSERVATIONS of a CIRCUMPOLAR STAR, COLLIMATOR, or the MERIDIAN MARK, with REVERSED POSITIONS of the TRANSIT AXIS.

Day.		Observer.	Object observed.	Reading of Micrometer for Coincidence of Center Wire with Optic Axis.	Day.		Observer.	Object observed.	Reading of Micrometer for Coincidence of Center Wire with Optic Axis.
1874.				r	1874.				r
October	2	T	Polaris............	20·274	October	10	T	Collimator.........	20·286
	3	T	λ Ursæ Minoris	20·232		15	T	Collimator.........	20·302
		NO	Polaris............	20·176			T	Collimator.........	20·304
	4	R	Polaris............	20·218			T	Cephei 51	20·316
	5	R	λ Ursæ Minoris	20·218		17	T	[At Noon, adjusted the Micrometer.]	
	6	T	λ Ursæ Minoris	20·266			T	Collimator.........	20·003
		T	Collimator.........	20·218		21	T	Polaris............	20·032
	10	T	Collimator.........	20·292					

Day.	Observer.	Object observed.	Reading of Micrometer for Coincidence of Centre Wire with Optic Axis.
1874.			r
October 28	T	Collimator.........	20·043
November 4	T	Meridian Mark.....	20·062
6	T	,, ...	20·072
		[At 4h. (Solar) adjusted the verticality of the wires and tightened up the screws.]	
	NI	5h. Meridian Mark..	20·068
	T	,, ,, ..	20·069
	T	18h. ,, ..	20·080
7	T	5h. ,, ..	20·068
	T	18h. ,, ..	20·070
	T	,, Collimator.....	20·072
8	T	Collimator.........	20·064
9	T	Meridian Mark.....	20·067
10	T	Collimator.........	20·085
	T	,, ...	20·075
	T	Meridian Mark.....	20·078
11	T	,, ...	20·076
15	NI	Collimator	20·083
	T	,, ...	20·080
21	T	,, ...	20·079
December 1	T	,, ...	20·096
	T	Meridian Mark	20·101
2	T	,, ...	20·097

Day.	Observer.	Object observed.	Reading of Micrometer for Coincidence of Center Wire with Optic Axis.
1874.			r
December 5	T	Meridian Mark.....	20·108
	NI	Collimator.........	20·109
6	T	Meridian Mark.....	20·102
10	NI	,, ...	20·108
11	T	,, ...	20·105
14	R	,, ...	20·094
18	T	,, ...	20·111
21	NI	,, ...	20·109
23	T	,, ...	20·109
26	NI	Mer. Mark (unsteady)	20·116
27	NI	Meridian Mark.....	20·113
1875.			
January 3	T	Meridian Mark	20·120
6	R	,, ...	20·126
10	T	,, ...	20·120
13	R	,, ...	20·114
16	T	,, ...	20·115
18	NI	,, ...	20·108
20	T	,, ...	20·111
24	R	,, ...	20·111
25	T	,, ...	20·111
28	NI	,, ...	20·111
31	T	,, ...	20·114
February 6	T	,, ...	20·110
8	T	,, ...	20·111

TABLE III.—AZIMUTH ERROR of the TRANSIT INSTRUMENT at HONOLULU, and OBSERVATIONS of the MERIDIAN MARK.

[The Sign + indicates that the Optic Axis points East of South.]

Day.	Approx. Local Mean Time.	Observer.	Stars or Meridian Mark.		Apparent Error of Azimuth.	Remarks.
1874.	h m				″	
October 2	12. 27	T	Polaris...........	κ Piscium	+15·42	
3	7. 0	T	λ Ursæ Minoris	ρ Capricorni	+12·70	
	12. 23	NO	Polaris	20 Ceti	+16·56	
4	12. 19	R	Polaris...........	ε Piscium	+17·50	

Day.	Approx. Local Mean Time.	Observer.	Stars or Meridian Mark.		Apparent Error of Azimuth.	Remarks.
1874.	h m				″	
October 5	3. 0	T	....		..	Azimuth and Level adjusted.
	6. 52	R	λ Ursæ Minoris	β Capricorni	− 0·06	
	12. 15	NO	Polaris............	ν Piscium	+ 6·84	
6	6. 49	T	λ Ursæ Minoris	β Capricorni	+ 2·32	
	12. 11	R	Polaris............	ξ^1 Ceti	+ 5·11	
7	6. 45	NI	λ Ursæ Minoris	ρ Capricorni	+ 1·75	
[illegible]	10. 17	T	Radcliffe 2705 S.P. .	μ Pegasi	+ 4·15	
	12. 5	R	Polaris............	67 Ceti	+ 6·83	
	17. 3	NO	δ Ursæ Minoris S.P.	κ Orionis...........	+ 7·43	
	17. 32	NO	Cephei 51	κ Orionis...........	+ 5·92	
9	12. 0	T	Polaris............	ν Piscium	+ 4·29	
	16. 59	[illegible]	δ Ursæ Minoris S.P.	Cephei 51	+ 7·43	
11	11. 52	NI	Polaris............	β Ceti	+ 4·67	
	17. 20	R	Cephei 51	γ Canis	+ 4·91	
12	11. 48	T	Polaris............	η Piscium	− 1·61	
14	11. 40	T	Polaris............	ε Piscium	+ 3·67	
15	11. 36	NO	Polaris............	ε Piscium	+ 1·63	
	16. 35	T	δ Ursæ Minoris S.P.	γ Geminorum	+ 4·85	
	17. 2	T	Cephei 51	ε Canis	+ 4·60	
16	11. 32	[illegible]	Polaris............	ν Piscium	+ 3·75	
17	16. 27	R	δ Ursæ Minoris S.P.	ν Geminorum	− 6·19	
	16. 56	R	Cephei 51	ε Canis	− 6·25	
19	11. 20	T	Polaris............	η Aquarii	− 7·35	Polaris boiling.
20	11. 16	NO	Polaris............	α Piscis Australis....	− 5·75	Polaris boiling.
21	11. 12	[illegible]	Polaris............	α Piscis Australis....	− 4·80	
	16. 40	NO	Cephei 51	γ Geminorum.......	− 5·88	
22	11. 8	T	Polaris............	ν Piscium	− 3·83	Cloudy.
23	11. 4	T	Polaris............	μ Andromedæ.......	− 3·48	
25	10. 56	NO	Polaris............	ν Piscium	− 0·12	
26	10. 52	T	Polaris............	α Ceti..............	− 5·60	Polaris flaring.
	16. 20	R	Cephei 51	ε Canis	− 0·64	
27	10. 48	[illegible]	Polaris............	ν Piscium	− 1·67	

Day.	Approx. Local Mean Time.	Observer.	Stars or Meridian Mark.		Apparent Error of Azimuth.	Remarks.
1874.	h m				"	
October 29	10. 40	E	Polaris	ν Piscium	+ 0·03	
30	10. 36	T	Polaris	o Piscium	− 2·64	
November 2	22. 27	T	Polaris S.P.	γ Pegasi	+ 1·60	
3	10. 21	NO	Polaris	β Ceti	− 5·62	
4	4. 0	T	M. M. {20·117 W. 20·008 E.}		− 5·20	
	15. 43	R	Cephei 51	γ Canis	− 3·79	
5	10. 13	R	Polaris	ϵ Piscium	− 5·92	Polaris flaring.
6	4. 0	T	M. M. {20·042 E. 20·102 W.}		− 6·46	
	4. 5	T	....		..	Adjusted the verticality of the wires and position of zero. Tightened the base clamp.
	4. 35	NI	M. M. {20·057 E. 20·079 W.}		− 7·76	
	4. 40	T	M. M. {20·058 E. 20·081 W.}		− 7·70	
	10. 10	NO	Polaris	ϵ Piscium	− 3·54	Polaris blurred.
	15. 9	E	δ Ursæ Minoris S.P.	ϵ Canis	− 3·53	
	18. 0	T	M. M. {20·174 W. 19·986 E.}		− 3·10	
7	5. 0	T	M. M. {20·104 W. 20·033 E.}		− 6·35	
	10. 6	R	Polaris	ν Piscium	− 4·47	
	15. 4	NO	δ Ursæ Minoris S.P.	θ Canis	− 5·23	
	15. 33	NO	Cephei 51	ϵ Canis	− 3·10	
	18. 30	T	M. M. {20·133 W. 20·007 E.}		− 4·78	
8	10. 1	T	Polaris	ν Piscium	− 2·03	
	16. 37	R	λ Ursæ Minoris S.P.	α Canis Minoris	− 2·20	λ very faint.
	18. 0	NI	M. M. 19·969 E.		− 2·75	
	23. 0	T	M. M. 20·090 W.		− 7·08	M. M. boiling.
9	5. 0	T	M. M. {20·050 W. 20·084 E.}		− 7·36	
	9. 54	R	Polaris	η Piscium	− 8·65	
	14. 58	NO	δ Ursæ Minoris S.P.	γ Geminorum	− 6·66	Rain and clouds.
	15. 24	NO	Cephei 51	ϵ Canis	− 5·01	Rain.
10	5. 0	T	M. M. 20·057 E.		− 7·20	
	9. 54	NO	Polaris	ν Piscium	− 5·29	Rain and cloud.

Day.	Approx. Local Mean Time.	Observer.	Stars or Meridian Mark.		Apparent Error of Azimuth.	Remarks.
	h m				″	
1874. November 10	19. 30	T	M. M. { 20·139 W. 20·017 E. }		− 4·89	
	5. 0	T	M. M. { 20·039 E. 20·113 W. }		− 6·24	
	9. 48	R	Polaris	ν Piscium	− 6·47	
	19. 0	T	M. M. 20·160 W.		− 3·71	
12	5. 0	NI T	M. M. { 20·137 W. 20·146 W. }		− 4·78	
	9. 45	T	Polaris	ν Piscium	− 1·16	
	14. 44	R	δ Ursæ Minoris S.P.	51 Geminorum	+ 0·53	
	15. 13	R	Cephei 51	δ Geminorum	− 0·38	
	16. 25	R	λ Ursæ Minoris S.P.	ξ Argûs	− 1·07	
	19. 0	NI	M. M. 20·247 W.		+ 1·13	
13	6. 0	NI T	M. M. { 20·168 W. 20·170 W. }		− 3·37	
	9. 41	NO	Polaris	ε Piscium	− 0·72	
	14. 48	T	δ Ursæ Minoris	51 Geminorum	+ 0·29	Very cloudy.
	15. 9	T	Cephei 51	γ Canis	+ 0·37	
	18. 0	NI	M. M. 20·229 W.		0·00	
14	5. 30	NI	M. M. 20·183 W.		− 2·53	
	9. 43	NO	Polaris	ε Piscium	− 0·95	Rain.
	15. 15	R	Cephei 51	β Canis	− 1·54	
	16. 15	R	λ Ursæ Minoris S.P.	α Canis Minoris	− 0·97	
	19. 30	NI	M. M. 20·222 W.		− 0·39	
15	9. 33	R	Polaris	η Piscium	− 1·73	
	18. 0	NI	M. M. 20·253 W.		+ 1·41	
16	..	..	...		..	Liquid cement was poured under the piers.
	9. 29	R	Polaris	α Ceti	− 1·08	
	20. 0	T	M. M. 19·901 E.		+ 1·75	
17	5. 30	NI	M. M. 19·969 E.		− 2·08	
	19. 0	NI	M. M. 19·931 E.		+ 0·06	
18	18. 30	NI	M. M. 19·950 E.		− 1·01	
21	19. 0	T	M. M. 20·197 W.		− 1·80	
22	5. 0	NI	M. M. 20·201 W.		− 1·57	
	9. 20	T	Polaris	o Piscium	+ 0·12	
	14. 6	NO	δ Ursæ Minoris S.P.	ν Geminorum	+ 1·39	
	14. 34	NO	Cephei 51	ε Canis	+ 1·89	

Day.	Approx. Local Mean Time.	Observer.	Stars or Meridian Mark.		Apparent Error of Azimuth.	Remarks.
1874.	h m				″	
November 22	15. 43	NO	λ Ursæ Minoris S.P.	ξ Argûs	+ 0·77	
	19. 0	T	M. M. 20·270 W.		+ 2·26	
23	5. 0	NI	M. M. 20·203 W.		− 1·57	
	..	T	M. M. 20·203 W.			
	9. 2	NO	Polaris	η Piscium	+ 2·58	Polaris boiling.
	13. 47	T	ε Ursæ Minoris S.P.	β Orionis	− 0·40	
	14. 4	R	δ Ursæ Minoris S.P.	γ Geminorum	− 1·02	Bad observation of δ.
	14. 31	R	Cephei 51	ε Canis	+ 2·65	
	15. 43	R	λ Ursæ Minoris S.P.	β Cancri	− 1·95	
	21. 0	NI	M. M. 20·260 W.		+ 1·64	
24	5. 30	T	M. M. 20·216 W.		− 0·95	
	8. 55	T	Polaris	α Eridani	+ 1·00	
	19. 0	T	M. M. 20·237 W.		+ 0·23	
25	18. 0	NI	M. M. 20·241 W.		+ 0·34	
	20. 53	T	Polaris S.P.	α Virginis	− 0·93	
26	4. 0	NI	M. M. 20·205 W.		− 1·74	
	5. 0	NI	M. M. 20·207 W.			
	8. 51	NO	Polaris	ν Piscium	+ 1·04	
	20. 30	NI	M. M. 20·250 W.		+ 0·74	
27	5. 0	NI	M. M. 20·236 W.		− 0·16	
	8. 47	NO	Polaris	ν Piscium	+ 1·09	
	13. 46	R	δ Ursæ Minoris S.P.	γ Geminorum	+ 1·41	
	14. 15	R	Cephei 51	ε Canis	+ 0·97	
	15. 25	R	λ Ursæ Minoris S.P.	α Canis Minoris	+ 0·34	
	18. 0	T	M. M. 20·281 W.		+ 2·09	M. M. boiling.
	18. 10	T	M. M. 20·271 W.			
28	5. 0	T	M. M. 20·197 W.		− 2·58	
	”	NI	M. M. 20·193 W.			
	8. 51	T	Polaris	67 Ceti	+ 0·01	
	14. 14	NO	Cephei 51	α Canis Minoris	+ 1·11	Cephei 51 faint.
	20. 0	T	M. M. 20·266 W.		+ 1·39	
29	5. 0	NI	M. M. 20·263 W.		+ 1·16	
	8. 38	R	Polaris	ν Piscium	+ 0·38	Polaris faint.
	18. 30	T	M. M. 19·915 E.		+ 1·75	
30	8. 32	NO	Polaris	θ Ceti	+ 1·53	Polaris blurred.
	13. 34	R	δ Ursæ Minoris S.P.	γ Geminorum	− 2·03	δ faint.
	14. 1	R	Cephei 51	ε Canis	− 0·73	Cephei 51 very faint.
	19. 30	NI	M. M. 19·986 E.		− 2·13	
December 1	8. 29	T	Polaris	α Eridani	+ 0·18	

Day.		Approx. Local Mean Time.	Observer.	Stars or Meridian Mark.		Apparent Error of Azimuth.	Remarks.
		h m				″	
1874. December	1	13. 30	NO	δ Ursæ Minoris, S.P.	β Canis Majoris	− 1·91	δ blurred.
		13. 59	NO	Cephei 51	ν Geminorum	+ 2·05	Cephei 51 blurred.
		19. 0	T	M. M. {19·964 E. / 20·238 W.}		− 0·45	
	2	5. 30	T	M. M. {19·981 E. / 20·213 W.}		− 1·96	
		13. 26	R	δ Ursæ Minoris S.P..	ν Geminorum	− 2·58	δ faint and unsteady.
		13. 55	R	Cephei 51	γ Geminorum	+ 0·89	
		15. 4	R	λ Ursæ Minoris S.P.	ξ Argûs............	+ 1·20	
		19. 0	T	M. M. 19·967 W.		− 0·84	
	3	5. 20	T	M. M. 19·972 W.		− 0·95	
		8. 23	T	Polaris	ζ Piscium	+ 1·71	
		19. 0	T	M. M. 19·931 E.		+ 1·36	
	4	5. 0	NI	M. M. 19·974 E.		− 0·95	
		8. 25	NO	Polaris	ν Piscium	+ 2·68	
		13. 18	R	δ Ursæ Minoris S.P.	η Geminorum	+ 0·90	
		13. 47	R	Cephei 51	γ Geminorum	+ 2·91	
		18. 45	NI	M. M. 19·917 E. }		+ 2·26	
		„	NI	M. M. 19·917 E. }			
	5	8. 14	R	Polaris	ν Piscium	+ 2·18	
		13. 13	NO	δ Ursæ Minoris S.P.	β Canis	+ 2·57	
		19. 0	T	M. M. {19·920 E. / 20·296 W.}		+ 2·26	
	6	5. 10	T	M. M. {19·944 E. / 20·260 W.}		+ 0·51	
		8. 11	T	Polaris	η Piscium	+ 1·84	
		21. 0	NI	M. M. 20·286 W.		+ 1·80	
	7	5. 30	NI	M. M. 20·279 W.		+ 1·36	
		8. 7	R	Polaris	η Piscium	+ 2·38	
		19. 25	NI	M. M. 20·313 W.		+ 3·27	
	8	5. 30	NI	M. M. 20·301 W.		+ 2·59	
		8. 3	NO	Polaris	ζ Piscium	+ 3·84	
		14. 39	T	λ Ursæ Minoris S.P.	6 Cancri	+ 0·94	λ faint.
		22. 0	NI	M. M. 20·296 W.		+ 2·31	
	9	6. 0	NI	M. M. 20·299 W.		+ 2·42	
		7. 59	NO	Polaris	θ Ceti..............	+ 2·28	
		12. 57	R	δ Ursæ Minoris S.P.	η Geminorum	+ 3·07	
		19. 30	NI	M. M. 20·324 W.		+ 3·83	

Day.	Approx. Local Mean Time.	Observer.	Stars or Meridian Mark.	Apparent Error of Azimuth.	Remarks.
1874.	h m			"	
December 10	5. 0	NI	M. M. 20·289 W.	+ 1·86	
	12. 53	NO	δ Ursæ Minoris S.P. ι Geminorum	+ 2·23	
	19. 30	NI	M. M. {20·332 W. 19·886 E.}	+ 4·22	
11	5. 0	T	M. M. {20·287 W. 19·924 E.}	+ 1·89	
	7. 50	NO	Polaris θ Ceti	+ 4·34	
	12. 50	R	δ Ursæ Minoris S.P. ν Orionis	+ 5·01	
	19. 0	NI	M. M. 19·879	+ 4·59	M. M. boiling.
12	5. 0	T	M. M. 19·928 E.	+ 1·80	
	7. 47	R	Polaris θ Ceti	+ 4·27	
	21. 0	NI	M. M. 19·883 E.	+ 4·34	
13	4. 30	NO	M. M. 19·884 E.	+ 4·28	
	7. 44	T	Polaris η Piscium	+ 7·55	
14	4. 30	R	M. M. {19·872 E. 20·316 W.}	+ 4·17	
	7. 39	R	Polaris η Piscium	+ 6·07	
15	5. 0	NO	M. M. 19·880 E.	+ 4·50	M. M. boiling.
	7. 34	NO	Polaris θ Ceti	+ 6·22	
	12. 34	R	δ Ursæ Minoris S.P. ν Orionis	+ 4·33	
	19. 0	NI	M. M. 19·850 E.	+ 6·19	
16	12. 30	NO	δ Ursæ Minoris S.P. η Geminorum	+ 7·15	δ blurred.
	13. 0	NO	Cephei 51 γ Geminorum	+ 7·67	Cephei 51 blurred.
	19. 0	NI	M. M. 19·847 E.	+ 6·36	
17	5. 0	NI	M. M. 19·878 E.	+ 4·62	
	7. 30	NO	Polaris η Piscium	+ 7·82	Polaris faint.
	12. 56	R	Cephei 51 ε Canis	+ 7·63	
	14. 3	R	λ Ursæ Minoris S.P. 15 Argûs	+ 6·32	
	19. 0	NI	M. M. 19·839 E.	+ 6·81	
18	7. 23	R	Polaris η Piscium	+ 8·05	
	19. 0	T	M. M. {19·825 E. 20·397 W.}	+ 7·77	
19	12. 17	NO	δ Ursæ Minoris S.P. γ Geminorum	+ 3·61	δ blurred.
	12. 47	NO	Cephei 51 γ Geminorum	+ 8·08	Cephei 51 flaring.
20	5. 0	NO	M. M. 20·350 W.	+ 5·24	
	12. 14	NO	δ Ursæ Minoris S.P. β Canis	+ 1·11	δ blurred.
	12. 44	NO	Cephei 51 β Canis	+ 6·19	

Day.	Approx. Local Mean Time.	Observer.	Stars or Meridian Mark.	Apparent Error of Azimuth.	Remarks.
1874.	h m			″	
December 21	5. 30	NI	M. M. {20·305 W. / 19·912 E.}	+ 2·73	
	12. 39	T	Cephei 51 .... ζ Geminorum	+ 5·19	
	13. 49	T	λ Ursæ Minoris S.P. β Geminorum	+ 5·36	
	20. 0	NI	M. M. 20·366 W.	+ 6·14	
22	19. 0	T	M. M. 20·353 W.	+ 5·40	
23	5. 30	T	M. M. {20·295 W. / 19·924 E.}	+ 2·11	
	19. 0	T	M. M. 19·901 E.	+ 3·38	M. M. boiling.
24	5. 30	NI	M. M. 19·911 E.	+ 2·82	
	13. 38	R	λ Ursæ Minoris S.P. β Cancri	+ 4·95	
25	19. 0	T	M. M. 19·910 E.	+ 2·87	M. M. boiling.
26	5. 30	NI	M. M. {19·924 E. / 20·309 W.}	+ 2·48	M. M. boiling.
27	5. 0	NI	M. M. {20·297 W. / 19·930 E.}	+ 2·00	
	18. 30	R	M. M. 20·327 W.	+ 3·72	M. M. boiling.
28	5. 25	NI	M. M. 20·314 W.	+ 2·90	
	17. 30	..	....	..	Three or four slight earthquake shocks.
	18. 45	T	M. M. 19·915	+ 2·88	M. M. boiling.
29	5. 30	R	M. M. 19·959 E.	+ 0·48	
	6. 39	R	Polaris .... 20 Ceti	+ 3·34	
	11. 38	NO	δ Ursæ Minoris S.P. η Geminorum	+ 4·76	
	12. 9	NO	Cephei 51 .... θ Canis	+ 4·70	
	18. 50	T	Polaris S.P. .... α Virginis	+ 4·86	
	18. 55	T	M. M. 19·901 E.	+ 3·72	M. M. boiling.
30	5. 25	NI	M. M. 19·946 E.	+ 1·24	
	12. 4	R	Cephei 51 .... γ Canis	+ 2·40	Cephei 51 faint.
	13. 14	R	λ Ursæ Minoris S.P. α Canis Minoris	+ 3·32	
	18. 32	NO	Polaris S.P. .... θ Virginis	+ 4·24	
	19. 0	NO	M. M. 19·885 E.	+ 4·66	M. M. boiling.
31	5. 30	R	M. M. 19·940 E.	+ 1·64	
	6. 35	R	Polaris .... θ Ceti	+ 2·43	
	18. 40	T	Polaris S.P. .... ε Virginis	+ 6·02	
	19. 0	T	M. M. 19·888	+ 4·56	M. M. boiling.
1875. January 1	11. 27	NO	δ Ursæ Minoris S.P. ν Geminorum	+ 5·05	
	11. 57	NO	Cephei 51 .... θ Canis	+ 5·21	

Day.		Approx. Local Mean Time.	Observer.	Stars or Meridian Mark.	Apparent Error of Azimuth.	Remarks.
1875.		h m			″	
January	1	18.41	T	Polaris S.P. .... τ Boötis	+ 6·00	
		18.50	T	M.M. 19·879 E.	+ 5·12	
	2	5.30	R	M.M. 19·936 E.	+ 1·97	
		11.24	R	δ Ursæ Minoris S.P. η Geminorum	+ 4·76	
		11.53	R	Cephei 51 .... γ Canis	+ 6·01	
		18.37	T	Polaris S.P. .... τ Virginis	+ 6·85	
	3	5.30	T	M.M. {19·930 E. 20·311 W.}	+ 2·42	
		18.20	R	Polaris S.P. .... ζ Virginis	+ 5·95	Polaris blurred.
		18.26	R	M.M. 19·868 E.	+ 5·86	M. M. boiling.
	4	5.30	R	M.M. 19·885 E.	+ 4·90	M. M. boiling.
		5.56	R	Polaris .... 11 Tauri	+ 6·55	Polaris blurred.
		18.15	R	Polaris S.P. .... θ Virginis	+ 5·33	Polaris blurred.
		18.30	R	M.M. 19·854 E.	+ 6·64	
	5	5.30	T	M.M. 19·938 E.	+ 1·97	
		6.12	T	Polaris .... ν Orionis	+ 4·27	
		11.12	R	δ Ursæ Minoris S.P. η Geminorum	+ 5·49	
		11.41	R	Cephei 51 .... θ Canis	+ 4·87	
	6	5.40	H	M.M. {19·932 E. 20·320 W.}	+ 2·59	
		6.4	H	Polaris .... η Geminorum	+ 3·91	
		11.17	T	δ Ursæ Minoris S.P. γ Geminorum	+ 6·05	
		11.37	T	Cephei 51 .... θ Canis	+ 5·62	
		18.7	R	Polaris S.P. .... θ Virginis	+ 4·52	
		18.30	R	M.M. 20·363 W.	+ 5·24	
	7	5.40	T	M.M. 20·345 W.	+ 4·22	M. M. boiling.
		5.42	T	Polaris .... ε Piscium	+ 5·00	
		18.5	T	Polaris S.P. .... Spica	+ 6·32	
		18.30	T	M.M. 20·399 W.	+ 7·26	M. M. boiling.
	8	5.30	NI	M.M. 20·322 W.	+ 2·99	
		6.0	NI	Polaris .... 37 Tauri	+ 3·57	
		18.0	T	Polaris S.P. .... α Virginis	+ 5·02	Polaris blurred.
		18.30	T	M.M. 20·378 W.	+ 6·14	M. M. boiling.
	9	11.25	T	Cephei 51 .... ξ Geminorum	+ 4·49	
		12.8	T	λ Ursæ Minoris S.P. α Canis Minoris	+ 4·72	
		17.55	R	Polaris S.P. .... θ Virginis	+ 5·19	
		18.30	H	M.M. 20·344 W.	+ 4·22	
	10	5.10	T	M.M. {20·285 W. 19·955 E.}	+ 0·96	

Day.		Approx. Local Mean Time.	Observer.	Stars or Meridian Mark.	Apparent Error of Azimuth.	Remarks.
1875.		h m			″	
January	10	10. 57	R	δ Ursæ Minoris S.P. γ Geminorum........	+ 3·02	
		11. 22	R	Cephei 51 .... θ Canis	+ 3·29	
		17. 54	T	Polaris S.P........ ζ Virginis	+ 3·86	
		18. 50	T	M. M. 20·361 W.	+ 5·24	M. M. boiling.
	11	5. 45	T	M. M. 20·310 W.	+ 2·48	
		5. 50	T	Polaris .... η Piscium	+ 3·61	
		10. 48	R	δ Ursæ Minoris S.P. η Geminorum	+ 5·42	
		11. 18	R	Cephei 51 .... θ Canis	+ 4·70	
		17. 48	T	Polaris S.P......... Spica	+ 4·65	
	12	5. 50	R	M. M. 20·318 W.	+ 3·04	
		17. 43	R	Polaris S.P......... θ Virginis	+ 5·65	
		18. 40	R	M. M. 20·359 W.	+ 5·35	M. M. boiling.
	13	5. 50	T	M. M. 20·301 W.	+ 2·14	
		5. 50	T	Polaris............ θ Ceti..............	+ 2·90	
		17. 40	R	Polaris S.P. .... θ Virginis	+ 5·56	
		18. 35	R	M. M. 20·353 W. }		
		19. 0	R	M. M. 20·380 W. }	+ 5·07	M. M. boiling.
		19. 10	R	M. M. 19·849 E. }		
	14	4. 30	R	M. M. 20·294 W.	+ 1·75	
		5. 36	R	Polaris............ ν Piscium	+ 2·08	
		18. 50	NI	M. M. 20·328 W.	+ 3·66	
	15	17. 31	R	Polaris S.P. .... α Virginis	+ 1·65	
		18. 35	R	M. M. 20·294 W.	+ 1·75	
	16	5. 25	T	M. M. {20·254 W. / 19·976 E.}	− 0·50	
		10. 33	R	δ Ursæ Minoris S.P. η Geminorum	− 1·06	
		11. 3	R	Cephei 51 .... γ Geminorum	+ 0·33	
		17. 30	NI	Polaris S.P......... Cephei 51	− 0·04	
	17	5. 0	NI	M. M. 20·266..........................	+ 0·25	
		5. 39	NI	Polaris............ ν Orionis	− 1·38	
		10. 33	R	δ Ursæ Minoris S.P. η Geminorum	+ 0·20	
		10. 53	R	Cephei 51 .... θ Canis	+ 0·80	
	18	5. 0	NI	M. M. {20·231 W. / 19·984 E.}	− 1·37	
		5. 20	NI	Polaris............ ν Piscium	− 0·52	
		5. 25	NI	M. M. 19·986 E.	− 1·51	M. M. boiling.
		10. 20	R	δ Ursæ Minoris S.P. β Canis	+ 1·11	
		10. 50	R	Cephei 51 .... ξ Geminorum	+ 0·81	
		19. 0	NI	M. M. 19·909 E.	+ 3·05	M. M. boiling.

Day.		Approx. Local Mean Time.	Observer.	Stars or Meridian Mark.		Apparent Error of Azimuth.	Remarks.
1875.		h m				"	
January	19	5. 35	T	Polaris	ν Piscium	− 3·47	
		5. 45	T	M. M. 20·053 E.		− 5·06	M. M. slowly oscillating 2" or 3" sideways.
		10. 15	T	δ Ursæ Minoris S.P.	η Geminorum	− 1·59	
		10. 45	T	Cephei 51	θ Canis	− 1·12	
		11. 35	T	λ Ursæ Minoris S.P.	β Canis Minoris	+ 1·72	λ boiling.
	20	5. 11	T	Polaris	β Andromedæ	− 3·75	
		5. 20	T	M. M. { 20·040 E. / 20·181 W. }		− 4·36	
		10. 16	R	δ Ursæ Minoris S.P.	γ Geminorum	− 2·81	
		10. 42	R	Cephei 51	ξ Geminorum	− 2·11	
		18. 55	T	M. M. 20·038 E.		− 4·16	
	21	5. 40	NI	M. M. 20·065 E.		− 5·73	
		11. 45	T	λ Ursæ Minoris S.P.	β Geminorum	− 3·24	λ blurred.
	22	5. 40	R	M. M. 20·168 W.		− 5·11	
		11. 40	T	λ Ursæ Minoris S.P.	6 Cancri	− 3·89	
	23	5. 40	NI	M. M. 20·145 W.		− 6·41	
		10. 5	R	δ Ursæ Minoris S.P.	γ Geminorum	− 3·18	
		10. 30	R	Cephei 51	ε Canis	− 3·21	
	24	6. 10	R	M. M. { 20·187 W. / 20·034 E. }		− 3·99	
		9. 55	NO	δ Ursæ Minoris S.P.	γ Geminorum	− 2·33	
		10. 25	NO	Cephei 51	γ Geminorum	− 2·34	
		16. 36	R	Polaris S.P.	31 Comæ	− 2·11	
	25	5. 35	T	M. M. { 20·190 W. / 20·030 E. }		− 3·82	
		16. 51	T	Polaris S.P.	θ Virginis	− 1·25	Polaris blurred.
		18. 50	NO	M. M. 20·236 W.		− 1·29	M. M. boiling.
	26	5. 50	NI	M. M. 20·205 W.		− 3·07	
		10. 18	NO	Cephei 51	ε Canis	− 0·09	
		16. 54	T	Polaris S.P.	ζ Virginis	− 1·31	
		19. 10	R	M. M. 19·984 E.		− 1·18	
	27	5. 55	NI	M. M. 20·010 E.		− 2·63	
		9. 44	R	δ Ursæ Minoris S.P.	η Geminorum	− 1·22	
		10. 14	R	Cephei 51	θ Canis	+ 0·42	
		16. 45	T	Polaris S.P.	α Virginis	− 0·14	
		19. 20	NO	M. M. 20·263 W.		+ 0·23	
	28	5. 50	NI	M. M. { 20·227 W. / 19·996 E. }		− 1·85	

Day.		Approx. Local Mean Time.	Observer.	Stars or Meridian Mark.		Apparent Error of Azimuth.	Remarks.
1875.		h m				″	
January	28	9. 45	NO	δ Ursæ Minoris S.P.	ν Geminorum	0·00	δ blurred.
		10. 12	NO	Cephei 51	θ Canis	+ 2·69	
		18. 40	T	M. M. 20·261 W.		+ 0·12	M. M. boiling.
	29	5. 50	NI	M. M. 20·224 W.		− 1·94	
		9. 36	R	δ Ursæ Minoris S.P.	η Geminorum	− 1·60	
		10. 5	R	Cephei 51	θ Canis.............	− 0·28	
		18. 30	T	M. M. 20·272 W.		+ 0·76	M. M. boiling.
	30	5. 50	NI	M. M. 19·996 E.		− 1·85	
		9. 31	NO	δ Ursæ Minoris S.P.	η Geminorum	+ 3·26	
		10. 0	NO	Cephei 51	θ Canis	+ 3·40	
		18. 40	T	M. M. 19·939		+ 1·36	
	31	5. 50	T	M. M. {19·990 E. / 20·237 W.}		− 1·38	
		9. 29	R	δ Ursæ Minoris S.P.	β Canis	+ 0·25	
		9. 58	R	Cephei 51	θ Canis	+ 1·37	
		18. 30	NO	M. M. 19·945 E.		+ 1·02	
February	1	5. 35	NI	M. M. 20·062 E.		− 5·56	
		9. 24	NI	δ Ursæ Minoris S.P.	η Geminorum	− 4·66	
		9. 54	R	Cephei 51	θ Canis	− 4·41	
	2	6. 0	NI	M. M. 20·071 E.		− 6·04	
		10. 58	NO	λ Ursæ Minoris S.P.	6 Cancri	− 5·43	λ faint.
	3	6. 0	NI	M. M. 20·066 E.		− 5·79	
		9. 47	NO	Cephei 51	θ Canis	− 4·20	
		10. 52	NO	λ Ursæ Minoris S.P.	β Geminorum	− 4·14	
	6	5. 40	T	M. M. {20·183 W. / 20·037 E.}		..	
		8. 58	NO	M. M. 20·212 W.		..	M. M. very steady.
		9. 4	NO	δ Ursæ Minoris S.P.	ν Geminorum	− 3·94	
		9. 27	NO	M. M. 20·207 W.		..	
		9. 33	NO	Cephei 51	γ Geminorum	− 2·02	
		10. 2	NO	M. M. 20·211 W.		..	
	7	6. 1	NO	M. M. 20·218 W.		..	
		8. 58	T	M. M. 20·234 W.		..	
		9. 7	T	δ Ursæ Minoris S.P.	δ Orionis...........	+ 0·43	
		9. 28	T	M. M. 20·247 W.		..	
		9. 36	T	Cephei 51	β Orionis	− 0·09	
		9. 59	T	M. M. 20·255 W.		..	
		10. 28	T	M. M. 20·281 W.		..	
		10. 37	T	λ Ursæ Minoris S.P.	β Tauri	+ 1·32	

Day.		Approx. Local Mean Time.	Observer.	Stars or Meridian Mark.	Apparent Error of Azimuth.	Remarks.
1875.		h m			"	
February	7	10. 56	T	M.M. 20·281 W.	..	
		15. 54	R	M.M. 20·303 W.	..	
		16. 1	R	Polaris S.P. .... β Tauri	+ 2·79	
		16. 29	NI	M.M. 20·260 W.	..	
	8	5. 54	T	M.M. {20·248 W. / 19·974 E.}	..	
		8. 30	T	M.M. 20·270 W.	..	
		8. 55	T	δ Ursæ Minoris S.P. γ^1 Eridani	+ 0·22	
		9. 0	T	M.M. 20·281 W.	..	
		10. 28	R	M.M. 20·272 W.	..	
		10. 39	R	λ Ursæ Minoris S.P. o^1 Eridani	+ 1·03	
		10. 58	R	M.M. 20·281 W.	..	
		15. 28	NI	M.M. 20·273 W.	..	
		15. 55	NI	Polaris S.P. .... o^1 Eridani	+ 1·45	
		16. 2	NI	M.M. 20·281 W.	..	
	9	8. 26	R	M.M. 20·271 W.	..	
		8. 51	R	δ Ursæ Minoris S.P. o^1 Eridani	+ 1·13	
		8. 58	R	M.M. 20·279 W.	..	
		9. 22	NI	Cephei 51 .... γ Tauri	+ 0·48	
		9. 29	NI	M.M. 20·289 W.	..	
		9. 55	NI	M.M. 20·248 W.	..	
		10. 22	NI	λ Ursæ Minoris S.P. γ Tauri	+ 0·82	
		10. 30	NI	M.M. 20·285 W.	..	
		15. 35	T	M.M. 20·325 W.	..	
		15. 52	T	Polaris S.P. .... α Serpentis	+ 3·24	
		16. 4	T	M.M. 20·315 W.	..	

TABLE IV.—MERIDIONAL TRANSITS of STARS and of the MOON observed at HONOLULU, and INFERRED ERROR of the TRANSIT-CLOCK.

Day.		Observer.	Reading and Position of Micrometer. [Adopted Reading for Zero of Collimation.]	Object observed and (Number of Wires).	Mean observed Clock-Time of Transit over the Center Wire.	Seconds of True Transit over the Meridian.	Seconds of Star's Assumed Apparent R. A.	Clock apparently Slow.
1874.			r		h m s	s	s	s
October	3	T	20·825 W.	λ Ursæ Minoris	19. 48. 17·60	42·02	46·08	4·06
			21·029 E.	λ Ursæ Minoris	19. 52. 57·60	42·31	46·08	3·77
			20·000 W.	ρ Capricorni	20. 21. 39·02	38·95	42·94	3·99
			[20·232]					

Day.	Observer.	Reading and Position of Micrometer. [Adopted Reading for Zero of Collimation.]	Object observed and (Number of Wires).	Mean observed Clock-Time of Transit over the Center Wire.	Seconds of True Transit over the Meridian.	Seconds of Star's Assumed Apparent R. A.	Clock apparently Slow.
1874.		r		h m s	s	s	s
October 3	NO	20·000 E.	20 Ceti	0. 46. 29·68	31·13	37·15	6·02
		17·750 E.	Polaris	1. 7. 28·00	15·00	21·22	6·22
		17·750 W.	Polaris	1. 20. 14·80	15·01	21·22	6·21
		[20·176]					
4	R	20·000 W.	ε Piscium	0. 56. 9·96	9·75	27·36	17·61
		21·500 W.	Polaris	1. 10. 20·80	3·34	21·13	17·79
		21·500 E.	Polaris	1. 17. 4·60	3·34	21·13	17·79
		[20·218]					
5	R	19·375 E.	λ Ursæ Minoris	19. 46. 23·00	16·06	43·27	27·21
		19·375 W.	λ Ursæ Minoris	19. 52. 3·00	16·05	43·27	27·22
		20·000 W.	β Capricorni	20. 13. 32·66	31·93	58·33	26·40
	NO	20·250 E.	Polaris	1. 13. 8·71	52·45	21·20	28·75
		20·000 E.	ν Piscium	1. 34. 25·54	26·62	55·53	28·91
		[20·218]					
7	NI	20·219 W.	λ Ursæ Minoris	19. 49. 50·06	37·33	40·67	3·34
		20·220 W.	ρ Capricorni	20. 21. 39·56	39·55	42·88	3·33
		[20·265]					
15	NO	20·233 W.	ε Piscium	0. 56. 10·14	9·92	27·43	17·51
		20·000 W.	Polaris	1. 13. 56·82	4·93	22·45	17·52
		[20·302]					
	T	20·233 W.	δ Ursæ Minoris S.P.	6. 12. 10·00	19·95	38·04	18·09
		20·233 W.	γ Geminorum	6. 30. 10·66	10·43	28·49	18·06
		23·000 W.	Cephei 51	6. 37. 31·67	54·80	12·90	18·10
		23·000 E.	Cephei 51	6. 44. 28·72	54·80	12·90	18·10
		20·233 E.	ε Canis Majoris	6. 53. 23·48	24·14	42·13	17·99
		[20·316]					
17	T	20·000 E.	Moon I.	19. 28. 41·12	40·45	..	[20·86]
		,,	ω Sagittarii	19. 47. 49·24	48·60	9·54	20·94
		,,	A Sagittarii	19. 50. 58·66	58·04	18·89	20·85
		,,	c Sagittarii	19. 54. 36·70	36·06	56·97	20·91
		,,	θ Aquilæ	20. 4. 29·64	29·23	50·21	20·98
		,,	α^2 Capricorni	20. 10. 45·48	44·97	6·02	21·05
		,,	ρ Capricorni	20. 21. 22·62	22·07	42·73	20·66
		,,	ε Delphini	20. 26. 53·28	52·96	13·54	20·58
		,,	α Delphini (4)	20. 33. 28·62	28·30	49·07	20·77
	R	20·250 E.	δ Ursæ Minoris S.P.	6. 12. 5·25	15·18	37·13	21·95
		20·000 E.	ν Geminorum	6. 21. 9·88	9·69	31·61	21·92
		20·000 E.	Cephei 51	6. 40. 45·67	52·22	14·00	21·78
		20·000 E.	ε Canis Majoris	6. 53. 20·88	20·40	42·18	21·78
		[20·003]					

October 17. The Azimuth Error from 19^h. to 21^h. has been taken $-8''\cdot3$.
,, ☽ $8^s\cdot1$, $24^s\cdot6$, $41^s\cdot0$, $57^s\cdot9$, $13^s\cdot9$.

Day.	Observer.	Reading and Position of Micrometer. [Adopted Reading for Zero of Collimation.]	Object observed and (Number of Wires).	Mean observed Clock-Time of Transit over the Center Wire.	Seconds of True Transit over the Meridian.	Seconds of Star's Assumed Apparent R. A.	Clock apparently Slow.
1874.		r		h m s	s	s	s
October 18	T	20·000 E.	θ Aquilæ (3)	20. 4. 27·68	27·28	50·19	22·91
		,,	α^2 Capricorni	20. 10. 43·48	42·99	6·00	23·01
		,,	β Capricorni	20. 13. 35·64	35·13	58·14	23·01
		,,	Moon I. (2)	20. 27. 26·00	25·41	..	[23·01]
		,,	67 Ceti	2. 10. 21·96	21·61	45·14	23·53
		,,	ξ^2 Ceti	2. 21. 7·66	7·41	30·88	23·47
		,,	ν Ceti	2. 28. 55·70	55·42	18·92	23·50
		,,	δ Ceti	2. 32. 41·40	41·09	4·73	23·64
		,,	γ^2 Ceti	2. 36. 26·38	26·09	49·54	23·45
		,, [20·006]	σ Arietis	2. 44. 12·14	11·93	35·49	23·56
19	NO	20·000 E.	33 Capricorni (2)	21. 16. 39·40	38·90	3·54	24·64
		,,	Moon I.	21. 24. 55·62	55·12	..	[24·71]
		,,	16 Pegasi (3)	21. 46. 57·14	57·05	21·95	24·90
		,,	α Aquarii	21. 58. 56·96	56·64	21·26	24·62
		,,	1 Pegasi	22. 0. 46·26	46·16	11·05	24·89
		,,	θ Aquarii	22. 9. 49·58	49·19	13·79	24·60
		,,	γ Aquarii	22. 14. 47·12	46·79	11·55	24·76
		,,	σ Aquarii	22. 23. 37·10	36·70	1·53	24·83
		,,	η Aquarii	22. 28. 31·10	30·78	55·60	24·82
	T	20·202 E. [20·013]	Polaris	1. 13. 10·75	57·25	22·25	25·00
20	R	20·000 E.	Moon I.	22. 20. 51·06	50·73	..	[26·72]
		,,	ζ Pegasi	22. 34. 46·56	46·40	13·30	26·90
		,,	α Piscis Australis	22. 50. 18·32	17·88	44·45	26·57
		,,	α Pegasi (4)	22. 58. 5·11	4·98	31·79	26·81
	NO	20·250 E.	Polaris	1. 13. 18·40	55·37	22·09	26·72
		20·000 E. [20·024]	ο Piscium (3)	1. 38. 20·88	20·76	47·68	26·92
21	T	20·000 E.	θ Aquarii	22. 9. 45·46	45·22	13·76	28·54
		,,	γ Aquarii	22. 14. 43·08	42·89	11·53	28·64
		,,	σ Aquarii	22. 23. 33·22	32·96	1·51	28·55
		,,	η Aquarii	22. 28. 27·16	26·97	55·58	28·61
		,,	μ Pegasi	22. 43. 29·22	29·20	57·89	28·69
		,,	λ Aquarii	22. 45. 36·90	36·66	5·24	28·58
		,,	α Piscis Australis	22. 50. 16·14	15·78	44·44	28·66
		,,	Moon I.	23. 16. 33·92	33·68	..	[28·66]
		18·023 E.	Polaris	1. 7. 25·36	54·64	21·92	27·28
		18·664 W.	Polaris	1. 16. 19·43	54·63	21·92	27·29
	NO	20·000 W.	γ Geminorum	6. 29. 59·52	59·23	28·68	29·45
		,, [20·032]	Cephei 51	6. 40. 42·88	45·98	16·15	30·17

October 18. ☽ ——, 9s·6, 26s·0, ——, ——. Azimuth Error, −6″·6. October 19. Azimuth Error, −8″·7.
,, 19. ☽ 24s·5, 39s·6, 55s·7, 11s·4, 26s·8. Good observation.
,, 20. ☽ 21s·0, 36s·1, 51s·0, 6s·2, 20s·9. Cloudy; good observation.
,, 21. ☽ 4s·0, 19s·1, 34s·0, 49s·0, 3s·4. Air very still.

Day.		Observer.	Reading and Position of Micrometer. [Adopted Reading for Zero of Collimation.]	Object observed and (Number of Wires).	Mean observed Clock-Time of Transit over the Center Wire.	Seconds of True Transit over the Meridian.	Seconds of Star's Assumed Apparent R. A.	Clock apparently Slow.
1874.			r		h m s	s	s	s
October	22	T	19·208 W.	Polaris	1. 14. 54·25	50·71	21·81	31·10
			20·000 W. [20·033]	ν Piscium	1. 34. 25·38	25·05	55·70	30·65
	23	T	20·000 W.	44 Piscium	0. 18. 27·72	27·39	59·70	32·31
			,,	12 Ceti	0. 23. 7·64	7·29	39·60	32·31
			,,	ε Andromedæ	0. 31. 24·84	24·59	57·08	32·49
			,,	β Ceti	0. 36. 47·10	46·69	19·18	32·49
			,,	δ Piscium (4)	0. 41. 39·73	39·42	11·84	32·42
			,,	20 Ceti	0. 46. 5·34	4·99	37·24	32·25
			,,	μ Andromedæ (4)	0. 49. 17·00	16·77	49·05	32·28
			20·000 W.	Moon I.	1. 5. 22·40	22·09	..	[32·40]
			16·379 W. [20·035]	Polaris	1. 22. 21·50	50·22	21·74	31·52
	24	NO	20·000 W.	20 Ceti	0. 46. 3·38	3·07	37·24	34·17
			,,	μ Andromedæ	0. 49. 15·06	14·76	49·05	34·29
			,,	ε Piscium	0. 55. 53·64	53·34	27·47	34·13
			,,	ζ¹ Piscium (3)	1. 6. 38·35	38·05	12·13	34·08
			19·973 W. [20·036]	Moon II. (4)	2. 2. 57·30	57·00	..	[34·18]
	25	NO	20·408 E.	Polaris	1. 13. 48·80	45·79	21·72	35·93
			20·000 E. [20·038]	ν Piscium	1. 34. 19·80	19·78	55·72	35·94
	26	T	20·000 E.	Polaris	1. 12. 24·42	36·98	21·72	44·74
		NO	20·000 E.	α Ceti	2. 55. 6·84	6·85	44·94	38·09
			,,	δ Arietis	3. 3. 50·82	50·87	29·03	38·16
			,,	τ Arietis	3. 13. 22·56	22·63	0·74	38·11
			,,	ο Tauri	3. 17. 27·24	27·26	5·39	38·13
			,,	*f* Tauri	3. 23. 20·22	20·25	58·45	38·20
			,,	ε Eridani	3. 26. 24·84	24·80	2·81	38·01
			,,	11 Tauri	3. 32. 40·34	40·41	18·39	37·98
			,,	δ Eridani	3. 36. 37·80	37·76	15·92	38·16
			,,	Moon II.	4. 10. 29·82	29·87	..	[38·17]
		R	19·000 E.	Cephei 51	6. 39. 20·00	43·81	18·89	35·08
			20·000 E. [20·039]	ε Canis	6. 53. 4·30	4·23	42·46	38·23
	27	R	20·000 E.	Polaris	1. 12. 32·44	40·57	21·69	41·12
			,,	ν Piscium	1. 34. 16·10	16·16	55·73	39·57
		NO	,,	ι Aurigæ	4. 48. 10·90	11·06	51·08	40·02
			,,	ε Leporis	4. 59. 30·60	30·69	10·47	39·78
			,,	β Orionis	5. 7. 51·94	52·02	31·86	39·84
			,,	B. A. C. 1648	5. 12. 27·96	28·11	8·30	40·19
			,,	Moon II.	5. 17. 12·06	12·21	..	[40·12]
			,,	δ Orionis	5. 24. 57·08	57·16	37·11	39·95
			,, [20·041]	ε Orionis	5. 29. 12·02	12·10	52·08	39·98

October 23. ☽ 53ˢ·4, 7ˢ·5, 22ˢ·5, 37ˢ·1, 51ˢ·6. Good observation.
" 24. ☽ 26ˢ·5, ——, 57ˢ·5, 12ˢ·2, 27ˢ·0. Cloudy; rain.
" 26. ☽ 57ˢ·7, 13ˢ·6, 29ˢ·8, 46ˢ·1, 1ˢ·8. Good observation.
" 27. ☽ 38ˢ·5, 55ˢ·3, 12ˢ·0, 29ˢ·1, 45ˢ·3. Much tremor.

Day.		Observer.	Reading and Position of Micrometer. [Adopted Reading for Zero of Collimation.]	Object observed and (Number of Wires).	Mean observed Clock-Time of Transit over the Center Wire.	Seconds of True Transit over the Meridian.	Seconds of Star's Assumed Apparent R. A.	Clock apparently Slow.
1874.			r		h m s	s	s	s
October	29	R	19·883 E.	Polaris (3)	1. 12. 14·33	37·58	21·42	43·84
			20·000 E. [20·045]	ν Piscium	1. 34. 12·34	12·40	55·74	43·34
November	4	R	20·000 E.	Cephei 51	6. 41. 40·11	49·18	23·27	−25·91
			20·063 E. [20·063]	γ Canis	6. 58. 32·30	32·08	5·99	−26·09
	5	R	20·063 E.	ε Piscium (3)	0. 56. 58·15	57·93	27·48	−30·45
			20·085 E. [20·067]	Polaris	1. 13. 42·80	49·88	19·36	−30·52
	14	NO	20·070 W.	ε Piscium	0. 56. 23·70	23·69	27·46	3·77
			17·575 W.	Polaris (1)	1. 19. 47·00	13·80	16·71	2·91
		R	20·070 W.	β Canis	6. 17. 8·50	8·49	12·00	3·51
			,,	Cephei 51	6. 41. 23·31	23·09	28·10	5·01
			,,	Procyon	7. 32. 41·60	41·61	45·27	3·66
			20·125 W. [20·080]	λ Ursæ Minoris S.P.	7. 48. 56·50	44·88	46·61	1·73
	15	NO	20·080 W.	θ Capricorni	20. 58. 50·30	50·25	53·98	3·73
			,,	Moon I.	21. 4. 22·82	22·77	..	[3·77]
			,,	ζ Cygni	21. 7. 31·82	31·80	35·78	3·98
			,,	ι Capricorni	21. 15. 12·16	12·12	16·04	3·92
			,,	ζ Capricorni	21. 19. 27·00	26·95	30·65	3·70
			,,	b Capricorni	21. 21. 31·00	30·95	34·67	3·72
			,,	β Aquarii	21. 24. 53·86	53·82	57·63	3·81
			,,	ξ Aquarii	21. 31. 1·08	1·04	4·80	3·76
			,,	ε Pegasi	21. 37. 57·98	57·95	1·85	3·90
		R	20·000 W.	Polaris	1. 13. 20·60	9·46	16·21	6·75
			20·080 W. [20·980]	η Piscium	1. 24. 44·12	44·12	47·84	3·72
	16	T	20·080 E.	Moon I.	21. 59. 4·58	4·41	..	[4·19]
			,,	θ Aquarii	22. 10. 9·40	9·24	13·45	4·21
			,,	45 Aquarii	22. 12. 13·42	13·26	17·50	4·24
			,,	γ Aquarii	22. 15. 7·18	7·03	11·22	4·19
			,,	σ Aquarii	22. 23. 57·22	57·06	1·21	4·15
			,,	η Aquarii	22. 28. 51·32	51·17	55·28	4·11
			,,	ζ Pegasi	22. 35. 8·90	8·75	12·96	4·21
			,,	λ Aquarii	22. 46. 1·02	0·86	4·97	4·11
		R	20·125 E.	Polaris	1. 13. 17·66	8·93	15·68	6·75
			20·080 E. [20·080]	α Ceti	2. 55. 41·12	41·01	45·15	4·14
	22	T	20·080 W.	Polaris	1. 13. 12·13	5·80	12·93	7·13
			,,	ο Piscium	1. 38. 43·12	42·92	47·79	4·87
			,,	β Arietis	1. 47. 39·62	39·38	44·28	4·90
			,, [20·081]	ε Trianguli	1. 55. 35·34	35·10	40·18	5·08

November 15. ☽ $51^s·3$, $7^s·0$, $23^s·1$, $38^s·8$, $54^s·0$. Daylight.
„ 16. ☽ $34^s·0$, $49^s·2$, $4^s·7$, $20^s·0$, $34^s·9$. Air still.

Day.		Observer.	Reading and Position of Micrometer. [Adopted Reading for Zero of Collimation.]	Object observed and (Number of Wires).	Mean observed Clock-Time of Transit over the Centre Wire.	Seconds of True Transit over the Meridian.	Seconds of Stars Assumed Apparent R. A.	Clock apparently Slow.
1874.			r		h m s	s	s	s
November	22	T	20·080 W.	α Arietis	2. 0. 3·16	2·92	7·88	4·96
			,,	67 Ceti (4)	2. 10. 40·52	40·37	45·33	4·96
			,,	ξ^2 Ceti	2. 21. 26·42	26·22	31·12	4·90
			,,	ν Ceti (4)	2. 29. 14·42	14·23	19·20	4·97
			,,	δ Ceti	2. 33. 0·20	0·03	5·00	4·97
			,,	γ^2 Ceti	2. 36. 45·12	44·94	49·84	4·90
			,,	π Arietis	2. 42. 14·56	14·34	19·43	5·09
			,,	ρ^2 Arietis	2. 48. 42·62	42·40	47·51	5·11
			,,	Moon I.	3. 32. 53·00	52·76	..	[4·99]
			,,	Moon II.	3. 35. 23·04	22·80	..	[4·99]
		NO	20·857 W.	δ Ursæ Minoris S.P.	6. 13. 6·00	20·21	24·35	4·14
			20·080 W.	ν Geminorum	6. 21. 27·82	27·62	32·69	5·07
			,,	Cephei 51	6. 41. 30·37	25·85	31·42	5·57
			,,	ε Canis	6. 53. 38·18	38·17	43·25	5·08
			,,	ξ Argûs	7. 43. 57·18	57·16	2·36	5·20
			20·750 W.	λ Ursæ Minoris S.P.	7. 50. 40·00	36·36	36·62	0·26
	23	NO	20·000 W.	Polaris	1. 13. 30·29	12·96	12·52	− 0·44
			20·080 W.	η Piscium	1. 24. 42·52	42·30	47·82	5·52
		T	20·080 W.	ε Tauri	4. 21. 14·34	14·14	19·51	5·37
			,,	α Tauri	4. 28. 40·18	40·00	45·37	5·37
			,,	τ Tauri	4. 34. 39·70	39·50	45·02	5·52
			,,	μ Eridani (4)	4. 39. 10·46	10·33	15·73	5·40
			,,	Moon II.	4. 41. 50·50	50·29	..	[5·49]
			,,	B. A. C. 1518	4. 48. 34·00	33·79	39·28	5·49
			,,	*k* Tauri (4)	4. 50. 25·59	25·38	30·90	5·52
			,,	ε Ursæ Majoris S.P.	4. 58. 38·12	39·29	44·01	4·72
			,,	Rigel	5. 8. 26·88	26·77	32·41	5·64
			,,	β Tauri	5. 18. 18·54	18·31	23·96	5·65
		R	21·750 W.	δ Ursæ Minoris S.P.	6. 14. 2·00	22·10	24·05	1·95
			20·080 W.	γ Geminorum	6. 30. 24·66	24·49	29·64	5·15
			20·000 W.	Cephei 51	6. 41. 37·78	27·88	31·95	4·07
			20·080 W.	ε Canis	6. 53. 37·92	37·89	43·28	5·39
			21·500 W.	λ Ursæ Minoris S.P.	7. 53. 1·20	42·12	35·66	− 6·46
			20·080 W. [20·083]	β Cancri	8. 9. 38·60	38·45	44·01	5·56
	26	NO	20·000 W.	Polaris	1. 13. 24·86	8·48	10·98	2·50
			20·080 W. [20·089]	ν Piscium	1. 34. 49·48	49·23	55·76	6·53
	27	NO	20·000 W.	Polaris	1. 13. 24·57	3·26	10·33	7·07
			20·080 W.	ν Piscium	1. 34. 49·10	48·85	55·76	6·91
		R	20·500 W.	δ Ursæ Minoris S.P.	6. 12. 39·36	16·74	22·86	6·12
			20·080 W. [20·091]	γ Geminorum	6. 30. 23·14	22·90	29·75	6·85

November 22. ☽ I. 21ˢ·5, 37ˢ·0, 53ˢ·0, 9ˢ·0, 14ˢ·6. Good observation.
☽ II. 51ˢ·5, 7ˢ·2, 23ˢ·1, 39ˢ·0, 54ˢ·5. Correction for defective illumination, +0ˢ·28.
,, 23. ☽ II. 17ˢ·8. 34ˢ·1, 50ˢ·5, 7ˢ·0, 23ˢ·2. Tremor.

Day.	Observer.	Reading and Position of Micrometer. [Adopted Reading for Zero of Collimation.]	Object observed and (Number of Wires).	Mean observed Clock-Time of Transit over the Centre Wire.	Seconds of True Transit over the Meridian.	Seconds of Stars Assumed Apparent R. A.	Clock apparently Slow.
1874.		r		h m s	s	s	s
November 27	R	20·000 W.	Cephei 51	6. 41. 36·67	25·22	33·72	8·50
		20·080 W.	ε Canis	6. 53. 36·44	36·36	43·38	7·02
		20·080 W.	Procyon	7. 32. 38·80	38·60	45·65	7·05
		21·000 W.	λ Ursæ Minoris S.P.	7. 51. 21·44	29·26	30·47	1·21
	T	20·080 W.	Moon II.	9. 1. 18·90	18·72	..	[7·12]
		,,	83 Cancri (3)	9. 11. 53·09	52·91	59·90	6·99
		,,	α Hydræ (4)	9. 21. 19·25	19·16	26·26	7·10
		,,	ξ Leonis	9. 25. 5·16	5·00	12·07	7·07
		,,	ο Leonis	9. 34. 21·26	21·11	28·27	7·16
		,,	ε Leonis	9. 38. 37·98	37·77	44·88	7·11
		,,	μ Leonis (4)	9. 45. 31·68	31·46	38·73	7·27
		,,	π Leonis	9. 53. 28·82	28·67	35·91	7·24
28	T	20·080 W.	Polaris	1. 13. 7·68	2·09	9·66	7·57
		,,	67 Ceti	2. 10. 38·18	37·94	45·33	7·39
	NO	17·829 W.	Cephei 51	6. 45. 7·00	26·32	34·09	7·77
		20·080 W.	Procyon	7. 32. 38·50	38·26	45·68	7·42
	R	20·080 W.	ο Leonis	9. 34. 21·18	21·02	28·30	7·28
		,,	ε Leonis	9. 38. 37·98	37·78	44·92	7·14
		,,	μ Leonis	9. 45. 31·78	31·58	38·77	7·19
		,,	Moon II.	9. 54. 40·46	40·28	..	[7·18]
		,,	37 Leonis	10. 9. 50·48	50·31	57·56	7·25
		,, [20·093]	γ¹ Leonis	10. 12. 57·36	57·17	4·21	7·04
29	R	20·000 W.	Polaris	1. 13. 21·57	58·40	8·96	10·56
		20·080 W.	ν Piscium	1. 34. 48·60	48·34	55·75	7·41
	T	20·080 E.	α Leonis (4)	10. 1. 34·70	34·51	42·33	7·82
		,,	γ¹ Leonis	10. 12. 56·80	56·58	4·24	7·66
		,,	ρ Leonis (4)	10. 26. 5·46	5·27	13·10	7·83
		,,	34 Sextantis (4)	10. 36. 1·87	1·71	9·45	7·74
		,,	Moon II.	10. 43. 30·44	30·25	..	[7·77]
		,, [20·094]	δ Leonis	11. 7. 19·16	18·94	26·76	7·82
December 1	T	20·080 E.	β Andromedæ	1. 2. 36·14	35·91	44.06	8·15
		19·573 E.	Polaris (4)	1. 11. 41·25	0·35	7·58	7·23
		20·080 E.	α Eridani	1. 32. 57·48	57·52	5·32	7·80
		,,	β Arietis (4)	1. 47. 36·46	36·25	44·27	8·02
		,,	α Arietis (3)	1. 59. 59·88	59·66	7·89	8·23
		,,	ν Ceti	2. 29. 11·48	11·30	19·22	7·92
		,,	δ Ceti	2. 32. 57·06	56·89	5·02	8·13
		,,	γ² Ceti	2. 36. 42·00	41·82	49·86	8·04
	NO	20·000 E.	δ Ursæ Minoris S.P.	6. 12. 20·71	15·79	21·96	6·17
		20·100 E. [20·098]	β Canis	6. 17. 4·50	4·28	12·39	8·11

November 27. ☽ $47^s·3$, $3^s·0$, $19^s·0$, $35^s·0$, $50^s·3$. Bad observation.
,, 28. ☽ $10^s·0$, $24^s·9$, $40^s·5$, $56^s·0$, $11^s·0$. Limb unsteady.
,, 29. ☽ $1^s·0$, $15^s·4$, $30^s·4$, $45^s·3$, $0^s·0$. Much tremor. Howling wind.

Day.	Observer.	Reading and Position of Micrometer. [Adopted Reading for Zero of Collimation.]	Object observed and (Number of Wires).	Mean observed Clock-Time of Transit over the Centre Wire.	Seconds of True Transit over the Meridian.	Seconds of Stars Assumed Apparent R. A.	Clock apparently Slow.
1874.		r		h m s	s	s	s
December 1	NO	20·100 E.	ν Geminorum	6. 21. 25·00	24·72	32·92	8·20
		20·000 E.	Cephei 51	6. 41. 24·00	29·50	35·07	5·57
	T	20·100 E.	Moon II.	12. 12. 47·76	47·54	..	[8·18]
2	R	19·643 E.	δ Ursæ Minoris S.P.	6. 12. 43·85	15·22	21·66	6·44
		20·100 E.	ν Geminorum (4)	6. 21. 25·06	24·81	32·95	8·14
		,,	γ Geminorum	6. 30. 21·80	21·55	29·87	8·32
		20·000 E.	Cephei 51	6. 41. 22·44	29·25	35·38	6·13
		20·100 E.	ξ Argûs	7. 43. 54·62	54·40	2·65	8·25
		19·500 E.	λ Ursæ Minoris S.P.	7. 50. 9·20	10·02	25·02	15·00
	T	20·100 E. [20·100]	Moon II.	12. 55. 51·02	50·79	..	[8·52]
4	NO	22·364 E.	Polaris	1. 19. 7·29	2·36	5·69	3·33
		20·100 E.	ν Piscium	1. 34. 47·32	47·09	55·73	8·64
	R	20·100 E.	η Geminorum	6. 7. 11·86	11·61	20·53	8·92
		20·250 E.	δ Ursæ Minoris S.P.	6. 12. 1·00	13·91	21·38	7·47
		20·100 E.	γ Geminorum	6. 30. 21·32	21·09	29·92	8·83
		19·750 E. [20·105]	Cephei 51	6. 41. 5·33	27·97	35·98	8·01
5	R	20·100 E.	ε Piscium	0. 56. 18·38	18·20	27·34	9·14
		,,	β Andromedæ	1. 2. 35·18	34·86	44·03	9·17
		20·000 E.	Polaris	1. 12. 48·89	55·46	5·11	9·65
		20·100 E.	ν Piscium	1. 34. 46·78	46·61	55·73	9·12
		,,	ο Piscium	1. 38. 38·88	38·69	47·74	9·05
		,,	β Arietis	1. 47. 35·40	35·15	44·26	9·11
	NO	,,	ν Orionis (4)	6. 0. 17·48	17·31	26·70	9·39
		,,	η Geminorum	6. 7. 11·44	11·24	20·55	9·31
		20·500 E.	δ Ursæ Minoris S.P.	6. 11. 43·00	11·60	21·19	9·59
		20·100 E.	β Canis Majoris	6. 17. 3·12	3·07	12·47	9·40
		,,	ν Geminorum	6. 21. 23·78	23·58	33·01	9·43
		,,	ζ Geminorum	6. 56. 32·98	32·78	42·21	9·43
		,,	δ Geminorum	7. 12. 30·74	30·54	39·92	9·38
		,, [20·106]	Procyon	7. 32. 36·50	36·36	45·87	9·51
6	T	20·000 W.	Polaris	1. 13. 20·40	56·52	4·56	8·04
		20·100 W. [20·106]	η Piscium	1. 24. 38·12	37·87	47·76	9·89
7	R	20·100 W.	ε Piscium	0. 56. 17·58	17·35	27·33	9·98
		,,	β Andromedæ	1. 2. 34·24	33·88	44·01	10·13
		20·000 W.	Polaris	1. 13. 21·22	54·14	3·98	9·84
		20·100 W.	η Piscium	1. 24. 38·02	37·76	47·76	10·00
		,,	ν Piscium	1. 34. 45·92	45·69	55·72	10·03
		,,	ο Piscium	1. 38. 37·96	87·72	47·73	10·01
		,, [20·107]	β Arietis	1. 47. 34·56	34·27	44·25	9·98

December 1. ☽ 19s·0, 33s·2, 47s·7, (2s·4), 16s·4. One hour after sunrise; limb bright and steady.
„ 2. ☽ 22s·0, 36s·3, 51s·0, 5s·7, 20s·0. Two hours after sunrise; limb very steady and fairly bright.

Day.		Observer.	Reading and Position of Micrometer. [Adopted Reading for Zero of Collimation.]	Object observed and (Number of Wires).	Mean observed Clock-Time of Transit over the Centre Wire.	Seconds of True Transit over the Meridian.	Seconds of Stars Assumed Apparent R. A.	Clock apparently Slow.
1874.			r		h m s	s	s	s
December	7	R	20·100 W.	α Arietis	1. 59. 58·04	57·74	7·87	10·13
			,,	ξ¹ Ceti	2. 6. 12·82	12·58	22·81	10·23
		NO	20·100 W.	ε Leporis	5. 0. 0·96	0·95	11·17	10·22
			,,	Rigel	5. 8. 22·34	22·26	32·62	10·36
			,,	β Tauri (4)	5. 18. 14·07	13·81	24·24	10·43
			,,	δ Orionis	5. 25. 27·60	27·48	37·96	10·48
			,,	α Leporis	5. 27. 3·76	3·72	13·94	10·22
			,,	ε Orionis	5. 29. 42·72	42·60	8·69	10·34
			,,	α Columbæ	5. 34. 58·36	58·43	52·94	10·26
			,,	κ Orionis	5. 41. 40·20	40·12	50·44	10·32
			,,	ν Orionis	6. 0. 16·60	16·41	26·74	10·33
	8	NO	20·100 W.	ε Andromedæ	0. 31. 46·50	46·19	56·80	10·61
			,,	β Ceti	0. 37. 8·30	8·19	18·91	10·72
			,,	δ Piscium	0. 42. 1·32	1·10	11·64	10·54
			,,	20 Ceti	0. 46. 26·62	26·44	37·04	10·60
			,,	ε Piscium	0. 56. 16·78	16·56	27·32	10·76
			,,	ζ¹ Piscium	1. 7. 1·52	1·30	12·03	10·73
			20·125 W.	Polaris	1. 13. 3·67	56·40	3·39	6·99
			20·100 W.	η Piscium	1. 24. 37·30	37·05	47·75	10·70
			,,	ν Piscium	1. 34. 45·12	44·91	55·71	10·80
		T	,,	β Canis Minoris	7. 20. 12·32	12·13	22·80	10·67
			,,	Castor (4)	7. 26. 27·69	27·40	38·00	10·60
			,,	Procyon	7. 32. 35·42	35·25	45·94	10·69
			,,	Pollux	7. 37. 30·02	29·76	40·46	10·70
			,,	ξ² Argûs	7. 43. 51·98	51·94	2·80	10·86
			20·569 W.	λ Ursæ Minoris S.P.	7. 49. 34·60	13·18	18·94	5·76
			20·100 W.	6 Cancri	7. 55. 40·36	40·10	50·85	10·75
			,,	α¹ Cancri	8. 16. 2·10	1·88	12·66	10·78
			,, [20·107]	ε Hydræ	8. 39. 58·98	58·81	9·54	10·73
	9	NO	20·100 W.	δ Piscium	0. 42. 0·94	0·71	11·63	10·92
			,,	20 Ceti	0. 46. 26·54	26·35	37·03	10·68
			,,	μ Andromedæ	0. 49. 38·40	38·03	48·75	10·72
			,,	ε Piscium	0. 56. 16·66	16·43	27·31	10·88
			,,	β Andromedæ	1. 2. 33·54	33·18	43·99	10·81
			,,	ζ¹ Piscium	1. 7. 1·32	1·09	12·02	10·93
			20·000 W.	Polaris	1. 13. 18·57	52·56	2·73	10·17
			20·100 W.	θ Ceti	1. 17. 35·78	35·61	46·66	11·05
			,,	η Piscium	1. 24. 37·12	36·86	47·75	10·89
		R	,,	η Geminorum	6. 7. 10·22	9·92	20·64	10·72
			20·000 W.	δ Ursæ Minoris S.P.	6. 11. 58·20	10·40	20·30	9·90
			20·100 W. [20·108]	β Canis	6. 17. 2·00	1·94	12·54	10·60

Day.		Observer.	Reading and Position of Micrometer. [Adopted Reading for Zero of Collimation.]	Object observed and (Number of Wires).	Mean observed Clock-Time of Transit over the Centre Wire.	Seconds of True Transit over the Meridian.	Seconds of Stars Assumed Apparent R. A.	Clock apparently Slow.
1874.			r		h m s	s	s	s
December	9	R	20·100 W.	ν Geminorum	6. 21. 22·70	22·41	33·10	10·69
			,,	θ Canis Majoris	6. 48. 12·96	12·86	23·63	10·77
			,,	ε Canis Majoris	6. 53. 33·06	33·07	43·65	10·58
			,,	γ Canis Majoris	6. 57. 56·26	56·19	6·89	10·70
			,,	51 Geminorum	7. 6. 1·62	1·36	12·18	10·82
			,,	δ Geminorum	7. 12. 29·46	29·17	40·03	10·86
	10	NO	20·100 W.	ε Leporis	4. 59. 59·96	59·98	11·19	11·21
			,,	Rigel	5. 8. 21·36	21·29	32·65	11·36
			,,	β Tauri	5. 18. 13·32	13·02	24·28	11·26
			,,	δ Orionis	5. 26. 26·82	26·70	38·00	11·30
			,,	α Leporis	5. 27. 2·74	2·74	13·97	11·23
			,,	ε Orionis	5. 29. 41·84	41·73	52·98	11·25
			,,	α Columbæ	5. 34. 57·42	57·52	8·72	11·20
			,,	κ Orionis	5. 41. 39·34	39·28	50·48	11·20
			,,	1 Geminorum (4)	5. 56. 21·00	20·74	32·03	11·29
			20·000 W. [20·108]	δ Ursæ Minoris S.P.	6. 11. 58·57	10·98	20·14	9·16
	14	R	20·100 E.	Moon I.	22. 34. 40·08	40·06	..	[11·83]
			,,	Fomalhaut	22. 50. 31·82	31·93	43·72	11·79
			,,	γ Piscium	23. 10. 28·62	28·47	40·33	11·86
			,,	κ Piscium	23. 20. 18·98	18·85	30·78	11·83
			,,	β Andromedæ	1. 2. 32·38	31·96	43·93	11·97
			20·250 E.	Polaris	1. 13. 29·86	46·93	58·67	11·74
			20·100 E.	η Piscium	1. 24. 35·92	35·69	47·71	12·02
			,,	ν Piscium	1. 34. 43·68	43·53	55·67	12·14
			,,	ο Piscium	1. 38. 35·88	35·71	47·69	11·88
			,,	β Arietis	1. 47. 32·60	32·33	44·21	11·88
			,, [20·108]	α Arietis	1. 59. 56·10	55·80	7·84	12·04
	15	NO	20·100 E.	α Pegasi	22. 58. 18·92	18·75	31·18	12·43
			,,	χ Aquarii	23. 10. 9·10	9·09	21·43	12·34
			,,	κ Piscium	23. 20. 18·46	18·39	30·77	12·38
			,,	B. A. C. 8184	23. 22. 51·40	51·37	3·66	12·29
			,,	Moon I.	23. 25. 50·02	50·00	..	[12·43]
			,,	ι Piscium	23. 33. 18·38	18·28	30·64	12·36
			,,	δ Sculptoris	23. 42. 11·82	11·95	24·46	12·51
			,,	ω Piscium (3)	23. 52. 40·52	40·41	53·04	12·63
			,,	2 Ceti	23. 57. 7·32	7·38	19·81	12·43
			,,	β Andromedæ	1. 2. 31·62	31·29	43·91	12·62
			,,	ζ¹ Piscium	1. 6. 59·60	59·50	11·98	12·48
			20·000 E.	Polaris	1. 12. 48·14	48·26	57·82	9·56
			20·100 E. [20·108]	θ Ceti	1. 17. 34·16	34·16	46·62	12·46

December 14. ☽ 10ˢ·0, 25ˢ·0, 39ˢ·8, 55ˢ·5, 10ˢ·0. Before sunset.
,, 15. ☽ 21ˢ·0, 35ˢ·2, 50ˢ·0, 4ˢ·8, 19ˢ·0.

Day.		Observer.	Reading and Position of Micrometer. [Adopted Reading for Zero of Collimation.]	Object observed and (Number of Wires).	Mean observed Clock-Time of Transit over the Centre Wire.	Seconds of True Transit over the Meridian.	Seconds of Stars Assumed Apparent R. A.	Clock apparently Slow.
			r		h m s	s	s	s
1874. December	15	NO	20·100 E.	η Piscium	1. 24. 35·46	35·30	47·70	12·40
		R	20·100 E.	ν Orionis	6. 0. 14·64	14·52	26·88	12·36
			20·000 E.	δ Ursæ Minoris S.P.	6. 12. 8·20	9·05	19·36	10·31
	16	R	20·100 E.	ι Ceti	0. 12. 50·62	50·74	3·19	12·45
			,,	Moon I.	0. 16. 42·06	42·11	..	[12·58]
			,,	δ Piscium	0. 41. 58·98	58·98	11·57	12·59
			,,	20 Ceti	0. 46. 24·40	24·46	36·96	12·50
			,,	μ Andromedæ (4)	0. 49. 36·31	36·05	48·66	12·61
			,,	ε Piscium	0. 56. 14·58	14·57	27·26	12·69
			,,	ζ¹ Piscium	1. 6. 59·30	59·30	11·97	12·67
			,,	ο Piscium	1. 38. 35·08	35·06	47·68	12·62
		NO	20·100 E.	η Geminorum	6. 7. 8·50	8·35	20·77	12·42
			19·462 E.	δ Ursæ Minoris S.P.	6. 12. 39·33	7·16	19·31	12·15
			20·100 E.	γ Geminorum	6. 30. 17·84	17·75	30·17	12·42
			20·573 E.	Cephei 51	6. 42. 14·25	27·45	39·52	12·07
		NI	20·100 E. [20·108]	Polaris S.P.	13. 12. 20·43	40·88	55·02	14·14
	17	NO	20·100 E.	β Andromedæ	1. 2. 31·02	30·72	43·89	13·17
			,,	Moon I.	1. 8. 37·74	37·95	..	[13·04]
			21·491 E.	Polaris	1. 16. 46·57	48·03	56·25	8·22
			20·100 E.	η Piscium	1. 24. 34·82	34·70	47·69	12·99
			,,	β Arietis (3)	1. 47. 31·36	31·20	44·19	12·99
		R	20·500 E.	Cephei 51	6. 42. 7·86	27·00	39·69	12·69
			20·100 E. [20·108]	ε Canis	6. 53. 30·42	30·79	43·81	13·02
			19·500 E.	λ Ursæ Minoris S.P.	7. 49. 35·20	0·05	10·40	10·35
			20·100 E.	15 Argûs	8. 2. 0·68	0·99	13·90	12·91
		NI	20·171 E.	Polaris S.P.	13. 12. 8·57	38·99	54·28	15·29
	18	R	20·262 E.	Polaris	1. 13. 30·00	43·03	55·52	11·49
			20·100 E.	η Piscium	1. 24. 34·34	34·26	47·68	13·42
			,,	ν Piscium	1. 34. 42·44	42·47	55·64	13·17
			,,	ο Piscium	1. 38. 34·38	34·38	47·66	13·28
			,,	β Arietis	1. 47. 30·88	30·78	44·18	13·40
			,,	B. A. C. 609	1. 52. 31·16	31·12	44·50	13·38
			,,	Moon I.	2. 3. 7·34	7·29	..	[13·33]
			,,	19 Arietis	2. 6. 1·30	1·23	14·48	13·25
			,,	67 Ceti	2. 10. 31·82	31·96	45·25	13·29
			,,	ξ² Ceti	2. 21. 17·62	17·62	31·09	13·47
		T	20·934 W. [20·109]	Polaris S.P. (1)	13. 14. 28·	39·73	53·57	13·84
	19	NO	20·100 W.	67 Ceti (3)	2. 10. 31·42	31·34	45·25	13·91
			,, [20·109]	ξ² Ceti	2. 21. 17·62	17·45	31·10	13·65

December 16. ☽ $13^s·0$, $27^s·5$, $42^s·0$, $56^s·7$, $11^s·0$.
,, 17. ☽ $8^s·7$, $23^s·0$, $37^s·6$, $52^s·5$, $6^s·8$. Through cloud.
,, 18. ☽ $37^s·3$, $52^s·3$, $7^s·4$, $22^s·6$, $37^s·0$. Good observation

Day.		Observer.	Reading and Position of Micrometer. [Adopted Reading for Zero of Collimation.]	Object observed and (Number of Wires).	Mean observed Clock-Time of Transit over the Centre Wire.	Seconds of True Transit over the Meridian.	Seconds of Stars Assumed Apparent R. A.	Clock apparently Slow.
1874.			r		h m s	s	s	s
December	19	NO	20·100 W.	ν Ceti	2. 29. 5·54	5·39	19·18	13·79
			,,	δ Ceti	2. 32. 51·40	51·28	4·98	13·70
			,,	γ^2 Ceti	2. 36. 35·96	35·82	49·82	14·00
			,,	σ Arietis	2. 44. 22·50	22·27	35·86	13·59
			,,	ε Arietis	2. 51. 50·72	50·45	4·36	13·91
			,,	α Ceti	2. 55. 31·56	31·41	45·22	13·81
			,,	Moon I.	3. 1. 29·80	29·54	..	[13·80]
			,,	δ Arietis	3. 4. 15·86	15·60	29·39	13·79
			,,	ν Orionis	6. 0. 12·84	12·79	26·94	14·15
			20·000 W.	δ Ursæ Minoris S.P.	6. 11. 53·71	7·10	19·03	11·93
			20·100 W.	ν Geminorum	6. 21. 19·10	19·01	33·20	14·28
			,,	γ Geminorum	6. 30. 16·36	16·30	30·22	13·92
			20·000 W.	Cephei 51	6. 41. 45·29	29·05	40·08	11·03
	20	NO	20·100 W.	ε Eridani	3. 26. 48·74	48·81	3·18	14·37
			,,	11 Tauri	3. 33. 4·70	4·59	18·94	14·35
			,,	δ Eridani	3. 37. 1·76	1·83	16·35	14·52
			,,	η Tauri	3. 39. 49·46	49·36	3·91	14·55
			,,	33 Tauri	3. 49. 25·46	25·36	39·92	14·56
			,,	γ^1 Eridani	3. 51. 58·02	58·10	12·65	14·55
			,,	37 Tauri	3. 57. 4·58	4·49	19·01	14·52
			,,	ω^1 Tauri	4. 1. 39·18	39·10	53·75	14·65
			,,	Moon I.	4. 4. 26·96	26·86	..	[14·51]
			,,	γ Tauri	4. 12. 27·02	26·96	41·52	14·56
			,,	χ^1 Tauri	4. 14. 44·92	44·81	59·32	14·51
			20·100 W.	δ Ursæ Minoris S.P.	6. 12. 2·00	7·89	18·91	11·02
			20·100 W.	β Canis	6. 16. 57·80	57·93	12·70	14·77
			19·671 W. [20·109]	Cephei 51	6. 42. 7·85	27·42	40·32	12·90
	21	T	20·100 W.	Moon I. (3)	5. 11. 23·01	22·86	..	[15·21]
			,,	Moon II.	5. 13. 56·18	56·03	..	[15·21]
			,,	Cephei 51	6. 41. 32·55	24·66	40·45	15·79
			,,	ζ Geminorum	6. 56. 27·30	27·25	42·57	15·32
			,,	51 Geminorum	7. 5. 57·16	57·13	12·45	15·32
			,,	28 Canis	7. 9. 29·86	30·11	45·38	15·27
			,,	δ Geminorum	7. 12. 25·10	25·03	40·31	15·28
			,,	1 Canis Minoris	7. 17. 47·12	47·13	2·36	15·23
			,,	β Canis Minoris	7. 20. 7·76	7·79	23·10	15·31
			,,	6 Canis Minoris	7. 22. 35·86	35·87	51·17	15·30
			,,	Castor (4)	7. 26. 23·37	23·23	38·35	15·12
			,,	25 Monocerotis (4)	7. 30. 49·24	49·35	4·51	15·16
			,, [20·109]	Procyon (4)	7. 32. 30·91	30·96	46·25	15·29

December 19. ☽ I. 59ˢ·0, 14ˢ·0, 29ˢ·8, 45ˢ·7, 0ˢ·6. Limb unsteady; raining.
,, 20. ☽ I. 55ˢ·1, 10ˢ·5, 27ˢ·0, 43ˢ·2, 59ˢ·1.
,, 21. ☽ I. 50ˢ·1, ——, 23ˢ·0, ——, 56ˢ·0. Overcast; limb very faint.
☽ II. 23ˢ·0, 39ˢ·5, 56ˢ·1, 13ˢ·0, 29ˢ·4. Correction for defective illumination, + 1ˢ·40.

Day.		Observer.	Reading and Position of Micrometer. [Adopted Reading for Zero of Collimation.]	Object observed and (Number of Wires).	Mean observed Clock-Time of Transit over the Centre Wire.	Seconds of True Transit over the Meridian.	Seconds of Stars Assumed Apparent R. A.	Clock apparently Slow.
1874.			r		h m s	s	s	s
December	21	T	20·100 W.	Pollux	7. 37. 25·76	25·64	40·82	15·18
			21·196 W.	λ Ursæ Minoris S.P.	7. 51. 12·40	52·81	7·31	14·50
	22	NO	20·100 W.	κ Orionis	5. 41. 34·70	34·84	50·61	15·77
			,,	α Orionis	5. 48. 9·40	9·43	25·14	15·71
			,,	Moon I.	6. 20. 2·92	2·80	..	[15·74]
			,,	Moon II.	6. 22. 37·36	37·24	..	[15·74]
			,,	γ Geminorum (4)..........	6. 30. 14·60	14·56	30·27	15·71
		T	20·993 W. [20·109]	Polaris S.P................	13. 24. 50·83	35·54	50·69	15·15
	23	NO	20·100 E.	Procyon....................	7. 32. 29·72	29·64	46·30	16·66
	24	R	20·100 E.	β Canis Minoris...........	7. 20. 5·86	5·86	23·16	17·30
			,,	Procyon....................	7. 32. 29·12	29·15	46·32	17·17
			,,	ξ Argûs	7. 43. 45·74	45·97	3·16	17·19
			19·000 E.	λ Ursæ Minoris S.P.	7. 51. 12·00	47·85	4·66	16·81
			20·100 E.	15 Argûs...................	8. 1. 56·68	56·91	14·05	17·14
			,,	β Cancri	8. 9. 27·66	27·66	44·88	17·22
			,,	α^1 Cancri	8. 15. 55·98	55·94	13·10	17·16
			,,	υ^2 Cancri.................	8. 20. 55·72	55·63	12·88	17·25
			,,	32 Cancri	8. 25. 20·30	20·21	37·50	17·29
			,,	Moon II..................	8. 32. 25·90	25·81	..	[17·24]
			,, [20·109]	κ Cancri...................	9. 0. 41·80	41·79	59·15	17·36
	29	R	20·100 E. [20·115]	20 Ceti	0. 46. 17·32	17·32	36·84	19·52
			20·000 E.	Polaris...................	1. 12. 19·40	29·58	46·27	16·69
		NO	20·100 E.	η Geminorum	6. 7. 1·08	0·98	20·95	19·97
			20·000 E.	δ Ursæ Minoris S.P.	6. 11. 59·71	58·26	18·22	19·96
			20·000 E.	Cephei 51	6. 41. 20·00	21·75	41·90	20·15
			20·100 E.	θ Canis...................	6. 48. 3·78	3·90	23·96	20·06
		T	20·100 E.	Moon II..................	12. 38. 28·90	29·00	..	[20·24]
			,,	31 Comæ (4)	12. 45. 16·14	16·05	36·38	20·33
			,,	δ Virginis	12. 48. 57·74	57·80	18·00	20·20
			,,	ε Virginis	12. 55. 36·48	36·50	56·86	20·36
			,,	θ Virginis	13. 3. 7·72	7·84	28·11	20·27
			,,	53 Virginis	13. 5. 3·34	3·53	23·72	20·19
			,,	Spica	13. 18. 15·44	15·59	35·76	20·17
			20·100 E.	Polaris S.P.	13. 12. 12·21	23·82	44·22	20·40
	30	R	20·100 E.	1 Geminorum	5. 56. 12·15	12·05	32·32	20·27
			20·100 E.	ν Orionis	6. 0. 6·88	6·81	27·06	20·25
			20·100 E. [20·116]	η Geminorum	6. 7. 0·71	0·60	20·96	20·36

December 22. ☽ I. 29s·8, 46s·1, 2s·9, 19s·9, 36s·0. Correction for defective illumination, −0s·12.
☽ II. 4s·2, 20s·8, 37s·1, 54s·1, 10s·7.
,, 24. ☽ II. 53s·8, 9s·8, 26s·0, 42s·0, 57s·8.
,, 29. ☽ II. 0s·0, 14s·2, 29s·0, 43s·4, 57s·8. Limb very steady

Day.		Observer.	Reading and Position of Micrometor. [Adopted Reading for Zero of Collimation.]	Object observed and (Number of Wires).	Mean observed Clock-Time of Transit over the Center Wire.	Seconds of True Transit over the Meridian.	Seconds of Stars Assumed Apparent R. A.	Clock apparently Slow.
1874.			r		h m s	s	s	s
December	30	R	20·542 E.	Cephei 51 (1)	6. 41. 59·	20·22	41·98	21·76
			20·100 E.	γ Canis	6. 57. 46·84	46·93	7·24	20·31
			,,	δ Geminorum	7. 12. 20·28	20·18	40·49	20·31
			,,	β Canis Minoris	7. 20. 3·04	3·01	23·26	20·25
			,,	Castor	7. 26. 18·26	18·11	38·55	20·44
			20·100 E.	Procyon	7. 32. 26·08	26·06	46·43	20·37
			18·840 E.	λ Ursæ Minoris S.P. (3)	7. 51. 43·00	41·21	0·92	19·71
			[20·116]					
		NO	20·100 E.	31 Comæ (3)	12. 45. 15·83	15·74	36·42	20·68
			,,	δ Virginis	12. 48. 57·50	57·52	18·03	20·51
			,,	ε Virginis	12. 55. 36·12	36·10	56·89	20·79
			,,	θ Virginis	13. 3. 7·48	7·54	28·14	20·60
			21·004 E.	Polaris S.P.	13. 9. 48·71	20·86	43·37	22·51
			20·100 E.	Spica	13. 18. 14·96	15·05	35·79	20·74
			,,	Moon II.	13. 22. 1·22	1·30	..	[20·65]
	31	R	20·000 E.	Polaris	1. 12. 14·00	23·31	44·55	21·24
			20·100 E.	θ Ceti	1. 17. 25·94	25·97	46·46	20·49
		T	20·100 E.	35 Virginis	12. 41. 8·06	8·15	29·20	21·05
			,,	31 Comæ	12. 45. 15·40	15·34	36·45	21·11
			,,	δ Virginis	12. 48. 56·94	57·03	18·07	21·04
			,,	ε Virginis	12. 55. 35·82	35·88	56·93	21·05
			21·250 E.	Polaris S.P.	13. 9. 7·28	16·45	42·55	26·10
			17·875 E.	Polaris S.P.	13. 18. 3·66	21·94	42·55	20·61
			20·100 E.	*h* Virginis	13. 26. 1·28	1·47	22·39	20·92
			,,	ζ Virginis (4)	13. 27. 57·85	57·96	18·82	20·86
			,,	*m* Virginis	13. 34. 41·36	41·53	2·35	20·82
			,,	τ Boötis	13. 40. 57·68	57·70	18·77	21·07
			,,	Moon II.	14. 6. 35·96	36·17	..	[21·01]
			,,	Arcturus	14. 9. 35·90	35·90	56·89	20·99
			[20·117]					
1875.								
January	1	NI	20·100 E.	Polaris	1. 12. 37·96	30·78	43·77	12·99
		NO	20·000 E.	δ Ursæ Minoris S.P.	6. 11. 58·86	57·32	18·23	20·91
			20·100 E.	ν Geminorum	6. 21. 12·22	12·26	33·48	21·22
			[20·118]					
			20·500 E.	Cephei 51	6. 41. 57·43	20·64	42·13	21·49
			20·100 E.	θ Canis	6. 48. 2·44	2·67	23·99	21·32
		T	18·912 E.	Polaris S.P.	13. 25. 26·57	18·37	41·77	23·40
			20·100 E.	τ Boötis (3)	13. 40. 57·12	57·16	18·81	21·65
			,,	η Boötis	13. 48. 21·94	21·98	43·41	21·43
			,,	τ Virginis	13. 54. 54·78	54·92	16·39	21·47
			,,	θ Centauri	13. 58. 56·76	57·18	18·63	21·45
			[20·118]					

December 30. ☽ 31ˢ·8, 46ˢ·3, 1ˢ·4, 16ˢ·0, 30ˢ·5. After sunrise.
" 31. ☽ 6ˢ·0, 20ˢ·9, 36ˢ·0, 51ˢ·0, 5ˢ·8. Limb bright and steady; an hour after sunrise.

Day.	Observer.	Reading and Position of Micrometer. [Adopted Reading for Zero of Collimation.]	Object observed and (Number of Wires).	Mean observed Clock-Time of Transit over the Center Wire.	Seconds of True Transit over the Meridian.	Seconds of Stars Assumed Apparent R. A.	Clock apparently Slow.
1875.		′		h m s	s	s	s
January 1	T	20·100 E.	κ Virginis (4)	14. 5. 51·27	51·49	12·83	21·34
		,,	Arcturus	14. 9. 35·52	35·55	56·92	21·37
		,,	ρ Boötis	14. 26. 4·38	4·33	25·83	21·50
		,,	ϵ^2 Boötis	14. 39. 9·34	9·31	30·85	21·54
		,,	α^2 Libræ	14. 43. 35·02	35·27	56·74	21·47
		,,	Moon II.	14. 53. 17·34	17·62	..	[21·48]
		[20·118]					
2	R	20·100 E.	Polaris	1. 12. 27·54	19·97	42·97	23·00
		,,	η Geminorum	6. 6. 59·54	59·56	20·99	21·43
		19·750 E.	δ Ursæ Minoris S.P.	6. 12. 14·83	57·93	18·22	20·29
		20·500 E.	Cephei 51	6. 41. 58·40	21·06	42·22	21·16
		20·100 E.	γ Canis	6. 57. 45·60	45·87	7·28	21·41
	T	20·100 E.	Polaris S.P.	13. 12. 3·76	16·35	40·98	24·63
		,,	τ Virginis (4)	13. 54. 54·32	54·51	16·42	21·91
		,,	κ Virginis	14. 5. 50·64	50·90	12·86	21·96
		,,	Arcturus	14. 9. 34·94	35·02	56·95	21·93
		,,	ϵ^2 Boötis	14. 39. 8·84	8·96	30·88	21·92
		,,	α^2 Libræ (4)	14. 43. 34·53	34·83	56·77	21·94
		[20·119]					
6	R	21·750 W.	Polaris	1. 8. 8·29	18·41	39·66	21·25
	T	20·100 W.	η Geminorum	6. 6. 56·22	56·09	21·02	24·93
		22·114 W.	{δ Ursæ Minoris S.P. on 5th wire}	6. 21. 53·	52·40	18·15	25·75
		20·100 W.	γ Geminorum	6. 30. 5·54	5·45	30·47	25·02
		20·000 W.	Cephei 51	6. 41. 34·50	18·04	42·67	24·63
		20·100 W.	θ Canis	6. 47. 58·92	59·02	24·03	25·01
		,,	ε Canis	6. 53. 18·78	18·98	44·04	25·06
		,,	ζ Geminorum	6. 56. 17·88	17·77	42·83	25·06
		,,	γ Canis (3)	6. 57. 42·18	42·30	7·32	25·02
		,,	51 Geminorum	7. 5. 47·74	47·65	12·71	25·06
	R	20·100 W.	θ Virginis	13. 3. 3·34	3·40	28·37	24·97
		19·750 W.	Polaris S.P. (3)	13. 11. 1·33	14·82	37·60	22·78
		[20·122]					
9	T	20·120 W.	γ Geminorum	6. 30. 2·64	2·62	30·49	27·87
		20·120 W.	ξ Geminorum (4)	6. 37. 49·59	49·60	17·51	27·91
		20·144 W.	Cephei 51	6. 41. 19·70	14·76	42·87	28·11
		20·120 W.	θ Canis Majoris	6. 47. 56·04	56·17	24·05	27·88
		,,	ε Canis Majoris	6. 53. 15·94	16·18	44·06	27·88
		,,	γ Canis Majoris	6. 57. 39·34	39·50	7·34	27·84
		,,	51 Geminorum	7. 5. 44·84	44·82	12·74	27·92
		,,	δ Geminorum	7. 12. 12·72	12·67	40·64	27·97
		20·988 W.	{λ Ursæ Minoris S.P. on wire 1}	7. 24. 38·20	27·65	55·81	28·16
		20·120 W.	Procyon	7. 32. 18·60	18·64	46·57	27·93
		,,	Pollux	7. 37. 13·36	13·27	41·20	27·93
		[20·121]					

January 1. ☽ $46^s{\cdot}6$, $2^s{\cdot}0$, $17^s{\cdot}0$, $33^s{\cdot}0$, $48^s{\cdot}0$. Wire 4 has been increased 1^s.

Day.	Observer.	Reading and Position of Micrometer. [Adopted Reading for Zero of Collimation.]	Object observed and (Number of Wires).	Mean observed Clock-Time of Transit over the Center Wire.	Seconds of True Transit over the Meridian.	Seconds of Stars Assumed Apparent R. A.	Clock apparently Slow.
1875.		r		h m s	s	s	s
January 9	R	20·120 W	θ Virginis	13. 3. 0·40	0·57	28·47	27·90
		20·125 W.	Polaris S.P.	13. 11. 55·83	7·13	34·63	27·50
11	T	20·111 W.	Polaris	1. 12. 17·17	8·27	34·71	26·44
		19·753 W.	η Piscium	1. 34. 19·52	18·05	47·44	29·39
	R	20·000 W.	δ Ursæ Minoris S.P.	6. 11. 36·00	48·36	18·35	29·99
		19·500 W.	Cephei 51	6. 42. 7·40	13·60	42·85	29·25
		20·120 W.	θ Canis	6. 47. 54·58	54·78	24·07	29·29
	T	20·046 W.	Polaris S.P.	13. 11. 38·80	2·84	32·62	29·78
		20·120 W. [20·118]	Spica	13. 18. 6·22	6·38	36·21	29·83
12	R	20·000 W.	Polaris	1. 12. 33·71	2·68	33·74	31·06
		20·120 W.	ε Virginis	12. 55. 26·86	26·90	57·52	30·62
		,,	θ Virginis	13. 2. 57·96	58·10	28·57	30·47
		19·958 W.	Polaris S.P.	13. 11. 20·67	0·41	31·67	31·26
		20·120 W.	Spica	13. 18. 5·60	5·78	36·24	30·46
		,,	ζ Virginis (4)	13. 27. 48·50	48·62	19·22	30·60
		,,	m Virginis	13. 34. 32·12	32·29	2·76	30·47
		,,	1 Centauri	13. 38. 3·86	4·20	34·71	30·51
		,,	τ Boötis	13. 40. 48·88	48·89	19·20	30·31
		,,	κ^1 Centauri (4)	13. 44. 5·42	5·76	36·34	30·58
		,,	τ Virginis	13. 54. 46·16	46·26	16·75	30·49
		,, [20·116]	κ Virginis	14. 5. 42·52	42·70	13·20	30·50
13	T	20·120 W.	μ Andromedæ	0. 49. 17·44	17·21	48·23	31·02
		,,	Moon I. (4)	0. 52. 33·10	33·02	..	[31·04]
		,,	ε Piscium	0. 55. 55·96	55·87	26·91	31·04
		,,	β Andromedæ	1. 2. 12·64	12·43	43·50	31·07
		20·125 W.	Polaris	1. 12. 10·33	2·81	32·82	30·01
		20·120 W.	θ Ceti	1. 17. 15·34	15·31	46·32	31·01
		,,	η Piscium	1. 24. 16·48	16·36	47·42	31·06
		,,	ζ^1 Piscium	1. 6. 40·76	40·67	11·69	31·02
	R	,,	θ Virginis	13. 2. 57·20	57·41	28·61	31·20
		20·000 W. [20·115]	Polaris S.P.	13. 11. 27·12	58·95	30·77	31·82
14	R	20·000 W.	Polaris	1. 12. 25·20	0·61	31·95	31·34
		20·120 W.	π Piscium	1. 29. 56·36	56·32	28·10	31·78
		,,	ν Piscium	1. 34. 23·64	23·62	55·39	31·77
		,,	Moon I. (2)	1. 43. 56·06	56·02	..	[31·79]
		,,	ξ Ceti (4)	2. 5. 50·69	50·67	22·51	31·84
		,,	ν Ceti	2. 28. 47·30	47·29	18·96	31·67
		,,	δ Ceti	2. 32. 32·86	32·87	4·77	31·90
		,,	γ^2 Ceti (4)	2. 36. 17·63	17·63	49·63	32·00
		,, [20·115]	σ Arietis	2. 44. 4·02	3·98	35·66	31·68

January 13. ☽ ——, $18^s·0$, $33^s·1$, $48^s·0$, $2^s·5$. Limb steady. Wire 2 bad. Before sunset.
„ 14. ☽ $26^s·6$, $41^s·0$, ——, ——, ——. Limb steady.

Day.		Observer.	Reading and Position of Micrometer. [Adopted Reading for Zero of Collimation.]	Object observed and (Number of Wires).	Mean observed Clock-Time of Transit over the Center Wire.	Seconds of True Transit over the Meridian.	Seconds of Stars Assumed Apparent R. A.	Clock apparently Slow.
1875.			r		h m s	s	s	s
January	15	R	20·120 W.	γ^2 Ceti (4)	2. 36. 17·40	17·40	49·62	32·22
			,,	Moon I.	2. 39. 14·72	14·72	..	[32·41]
			,,	47 Arietis (4)	2. 50. 23·87	23·86	56·24	32·38
			,,	α Ceti (4)	2. 55. 12·50	12·49	45·03	32·54
			,,	δ Arietis (3)	3. 3. 56·83	56·82	29·23	32·41
			,,	o Tauri	3. 17. 33·06	33·05	5·65	32·60
			,,	f Tauri	3. 23. 26·36	26·35	58·76	32·41
			,,	ϵ Eridani	3. 25. 30·76	30·76	3·01	32·25
			,,	γ^1 Eridani	3. 51. 40·00	40·00	12·51	32·51
			,,	37 Tauri	3. 56. 46·44	46·43	18·93	32·50
			,,	ω^1 Tauri	4. 1. 21·18	21·17	53·67	32·50
			20·125 W.	Polaris S.P.	13. 11. 52·33	56·47	29·12	32·65
			20·120 W. [20·115]	Spica	13. 18. 3·54	3·55	36·34	32·79
	16	R	20·120 W.	11 Tauri	3. 32. 45·96	45·79	18·79	33·00
			,,	Moon I.	3. 38. 31·04	30·87	..	[33·14]
			,,	27 Tauri (4)	3. 41. 11·24	11·07	44·30	33·23
			,,	γ^1 Eridani	3. 51. 39·42	39·27	12·50	33·23
			,,	37 Tauri	3. 56. 45·86	45·69	18·92	33·23
			,,	ω^1 Tauri	4. 1. 20·70	20·53	53·66	33·13
			,,	o^1 Eridani	4. 5. 13·44	13·29	46·51	33·22
			,,	γ Tauri	4. 12. 8·42	8·26	41·46	33·20
			,,	η Geminorum	6. 6. 47·96	47·88	21·06	33·18
			20·120 W.	δ Ursæ Minoris S.P. (2)	6. 11. 46·73	46·27	18·85	32·58
			,,	γ Geminorum	6. 29. 57·46	57·39	30·53	33·14
			,,	Cephei 51 (1)	6. 41. 9·33	9·04	42·60	33·56
		NI	,, [20·114]	Polaris S.P. (3)	13. 11. 54·33	54·79	28·33	33·54
	17	NI	20·120 W.	Polaris	1. 11. 54·32	53·77	29·53	35·76
		R	,,	Moon I. (1)	4. 41. 56·6	56·52	..	[33·57]
			,,	ν Orionis (4)	5. 59. 53·68	53·61	27·16	33·55
			,,	η Geminorum	6. 6. 47·48	47·40	21·06	33·66
			21·554 W.	δ Ursæ Minoris S.P. (2)	6. 17. 18·50	45·60	18·93	33·33
			20·120 W.	γ Geminorum	6. 29. 56·94	56·87	30·53	33·66
			,,	ξ Geminorum	6. 37. 44·00	43·93	17·56	33·63
			19·500 W.	Cephei 51	6. 41. 58·60	9·43	42·60	33·17
			,, [20·113]	θ Canis	6. 47. 50·58	50·54	24·09	33·55
	18	NI	20·120 E.	Polaris	1. 11. 57·60	55·70	28·70	33·00
			,,	ν Piscium	1. 34. 21·46	21·24	55·34	34·10
		R	,,	136 Tauri	5. 44. 55·24	55·10	29·41	34·31
			,,	Moon I.	5. 48. 19·92	19·79	..	[34·19]
			, [20·111]	1 Geminorum	5. 55. 58·42	58·30	32·41	34·11

January 15. ☽ 44ˢ·4, 59ˢ·5, 14ˢ·7, 30ˢ·0, 45ˢ·1. Limb steady.
,, 16. ☽ 59ˢ·6, 15ˢ·0, 31ˢ·0, 47ˢ·0, 2ˢ·7.
,, 17. ☽ ——, ——, 56ˢ·6, ——, ——. Overcast. δ Ursæ Minoris on Wire d.
,, 18. ☽ 46ˢ·8, 3ˢ·0, 20ˢ·0, 36ˢ·7, 53ˢ·0. Limb very steady.

Day.		Observer.	Reading and Position of Micrometer. [Adopted Reading for Zero of Collimation.]	Object observed and (Number of Wires).	Mean observed Clock-Time of Transit over the Center Wire.	Seconds of True Transit over the Meridian.	Seconds of Stars Assumed Apparent R. A.	Clock apparently Slow.
1875.			r		h m s	s	s	s
January	18	R	20·120 E.	ν Orionis	5. 59. 53·04	52·93	27·16	34·23
			,,	κ Aurigæ	6. 6. 51·92	51·78	26·03	34·25
			19·500 E.	δ Ursæ Minoris S.P.	6. 12. 22·00	44·76	19·00	34·24
			20·120 E.	β Canis Majoris	6. 16. 38·84	38·78	12·87	34·09
			,,	ν Geminorum	6. 20. 59·56	59·44	33·59	34·15
			,,	γ Geminorum	6. 29. 56·50	56·39	30·54	34·15
			,,	ξ Geminorum	6. 37. 43·36	43·25	17·57	34·32
			21·500 E.	Cephei 51	6. 42. 58·00	8·08	42·59	34·51
	19	T	20·120 E.	ν Piscium (4)	1. 34. 20·78	20·48	55·33	34·85
			21·873 E.	Polaris on 5th wire (4)	1. 36. 35·50	55·03	27·82	32·79
			20·120 E.	η Geminorum	6. 6. 47·36	46·12	21·07	34·95
			,,	δ Ursæ Minoris S.P.	6. 11. 44·30	45·47	19·07	33·60
			,,	β Canis Majoris	6. 16. 38·20	38·00	12·87	34·87
			,,	ν Geminorum	6. 20. 58·88	58·64	33·59	34·95
			,,	γ Geminorum	6. 29. 55·90	55·67	30·54	34·87
			,,	ξ Geminorum	6. 37. 42·72	42·49	17·57	35·08
			20·369 E.	Cephei 51	6. 41. 27·80	6·61	42·59	35·98
			20·120 E.	θ Canis	6. 47. 49·34	49·14	24·09	34·95
			,,	Moon I.	6. 55. 10·42	10·17	..	[34·97]
			,,	51 Geminorum	7. 5. 38·06	37·83	12·83	35·00
			,,	δ Geminorum	7. 12. 5·94	5·70	40·73	35·03
			,,	ι Geminorum	7. 17. 24·36	24·11	59·13	35·02
			,,	β Canis Minoris	7. 19. 48·74	48·53	23·50	34·97
			,, [20·111]	λ Ursæ Minoris S.P.	7. 47. 19·08	23·19	53·54	30·35
	20	T	20·120 E.	β Andromedæ	1. 2. 8·36	8·11	43·39	35·28
			19·983 E.	Polaris	1. 11. 25·66	52·26	26·88	34·62
		R	20·110 E.	δ Ursæ Minoris S.P.	6. 11. 46·12	44·49	19·15	34·66
			,,	γ Geminorum	6. 29. 55·74	55·52	30·55	35·03
			,,	ξ Geminorum	6. 37. 42·54	42·31	17·58	35·27
			21·231 E.	Cephei 51 (2)	6. 42. 33·50	7·74	42·57	34·83
			20·110 E.	θ Canis Majoris (2)	6. 47. 49·29	49·02	24·10	35·07
			,,	ε Canis Majoris	6. 53. 9·20	8·91	44·09	35·18
			,,	γ Canis Majoris	6. 57. 32·54	32·27	7·40	35·13
			,,	δ Geminorum (2)	7. 12. 5·88	5·66	40·74	35·08
			,,	ι Geminorum (4)	7. 17. 23·99	23·77	59·10	35·33
			,,	Procyon	7. 32. 11·62	11·38	46·69	35·31
			,,	Pollux	7. 37. 6·32	6·11	41·34	35·23
			,,	ξ Argûs	7. 43. 28·68	28·39	3·50	35·11
			,,	Moon I.	7. 59. 34·60	34·38	..	[35·20]
			,,	Moon II.	8. 2. 1·84	1·62	..	[35·20]
			,, [20·111]	β Cancri (4)	8. 9. 10·38	10·15	45·37	35·22

January 19. ☽ I. $37^{s}·4$, $53^{s}·9$, $10^{s}·4$, $27^{s}·0$, $43^{s}·3$. Some tremor.
„ 20. ☽ I. $2^{s}·4$, $18^{s}·2$, $34^{s}·6$, $51^{s}·0$, $6^{s}·9$. Some tremor.
☽ II. $29^{s}·5$, $45^{s}·6$, $1^{s}·9$, $18^{s}·1$, $34^{s}·2$. Correction for defective illumination, $+0^{s}·07$.

Day.		Observer.	Reading and Position of Micrometer. [Adopted Reading for Zero of Collimation.]	Object observed and (Number of Wires).	Mean observed Clock Time of Transit over the Center Wire.	Seconds of True Transit over the Meridian.	Seconds of Stars Assumed Apparent R. A.	Clock apparently Slow.
1875.			r		h m s	s	s	s
January	21	T	20·110 W.	Pollux	7. 37. 5·76	5·55	41·35	35·80
			20·798 W. [20·111]	λ Ursæ Minoris S.P.	7. 49. 43·29	17·26	53·07	35·81
	22	T	20·127 W.	λ Ursæ Minoris S.P.	7. 47. 30·43	16·71	52·93	36·22
			20·110 W.	6 Cancri	7. 55. 15·80	15·61	51·83	36·22
		R	,,	Moon II.	9. 56. 42·48	42·30	..	[36·09]
			,,	37 Leonis	10. 9. 23·18	22·99	59·25	36·26
			,,	μ Hydræ	10. 19. 27·92	27·63	3·62	35·99
			,,	ρ Leonis	10. 25. 38·88	38·68	14·76	36·08
			,,	l Leonis	10. 42. 6·30	6·10	42·16	36·06
			,,	δ Leonis	11. 6. 52·70	52·54	28·59	36·05
			,,	δ Crateris (2)	11. 12. 30·30	30·02	6·21	36·19
			,,	υ Leonis	11. 29. 57·74	57·51	33·60	36·09
			,, [20·111]	β Leonis	11. 42. 5·76	5·58	41·77	36·19
	23	R	20·110 W.	δ Ursæ Minoris S.P.	6. 11. 45·77	43·25	19·56	36·31
			,,	γ Geminorum	6. 29. 54·44	54·26	30·55	36·29
			18·750 W.	Cephei 51	6. 42. 49·16	5·89	42·34	36·45
			20·110 W.	ε Canis Majoris	6. 53. 7·96	7·65	44·08	36·43
		NO	,,	ρ Leonis	10. 25. 38·54	38·38	14·78	36·40
			,,	34 Sextantis	10. 35. 34·70	34·52	11·13	36·61
			,,	l Leonis	10. 42. 5·92	5·77	42·19	36·42
			,,	Moon II.	10. 47. 3·04	2·89	..	[36·51]
			,,	d Leonis	10. 53. 30·80	30·63	7·17	36·54
			,,	χ Leonis	10. 57. 58·60	58·44	35·04	36·60
			,,	δ Leonis (4)	11. 6. 52·37	52·24	28·61	36·37
			,, [20·111]	δ Crateris	11. 12. 29·84	29·63	6·24	36·61
	24	NO	20·000 W.	δ Ursæ Minoris S.P.	6. 11. 37·43	42·84	19·73	36·89
			20·110 W.	γ Geminorum	6. 29. 53·86	53·67	30·55	36·88
			20·000 W.	Cephei 51	6. 41. 12·43	5·31	42·19	36·88
		R	20·110 W.	υ Leonis	11. 29. 57·00	56·89	33·65	36·76
			,,	Moon II.	11. 34. 1·70	1·60	..	[36·89]
			,,	ν Virginis	11. 38. 50·04	49·95	26·84	36·89
			,,	β Virginis (4)	11. 43. 34·89	34·79	11·73	36·94
			,,	π Virginis	11. 53. 51·94	51·85	28·77	36·92
			,,	η Virginis	12. 12. 54·44	54·33	31·17	36·84
			,,	ρ Virginis	12. 34. 57·08	56·99	34·03	37·04
			,,	35 Virginis	12. 40. 53·24	53·14	29·99	36·85
			,,	31 Comæ	12. 45. 0·48	0·43	37·32	36·89
			,, [20·111]	Polaris S.P.	13. 11. 48·49	43·92	20·80	36·88

January 22. ☽ 12^s·1, 27^s·1, 42^s·5, 58^s·0, 12^s·8.
,, 23. ☽ 33^s·6, 48^s·2, 3^s·0, 18^s·0, 32^s·5.
,, 24. ☽ 32^s·8, 47^s·0, 1^s·7, 16^s·2, 30^s·9.

Day.		Observer.	Reading and Position of Micrometer. [Adopted Reading for Zero of Collimation.]	Object observed and (Number of Wires).	Mean observed Clock Time of Transit over the Center Wire.	Seconds of True Transit over the Meridian.	Seconds of Stars Assumed Apparent R. A.	Clock apparently Slow.
1875.			r		h m s	s	s	s
January	25	T	20·110 W.	η Virginis	12. 12. 53·94	53·80	31·20	37·40
			,,	Moon II.	12. 18. 53·40	53·26	..	[37·45]
			,,	τ Centauri	12. 30. 15·38	15·19	52·62	37·43
			,,	ρ Virginis	12. 34. 56·74	56·61	34·06	37·45
			,,	35 Virginis	12. 40. 52·54	52·40	30·02	37·62
			,,	31 Comæ	12. 44. 59·90	59·78	37·35	37·57
			,,	δ Virginis	12. 48. 41·54	41·40	18·89	37·49
			,,	ε Virginis	12. 55. 20·42	20·29	57·76	37·47
			,,	θ Virginis	13. 2. 51·70	51·56	28·99	37·43
			20·094 W.	Polaris S.P.	13. 11. 41·37	42·40	19·87	37·47
			20·110 W.	Spica	13. 17. 59·44	59·30	36·67	37·31
			,,	ζ Virginis	13. 27. 42·34	42·20	19·65	37·45
			,, [20·110]	η Ursæ Majoris	13. 42. 0·24	0·13	37·69	37·56
	26	NO	19·500 W.	Cephei 51	6. 41. 52·80	6·27	41·86	35·59
			20·110 W.	ε Canis Majoris	6. 53. 6·62	6·43	44·07	37·64
			,,	ζ Geminorum	6. 56. 5·40	5·27	42·96	37·69
			,,	51 Geminorum	7. 5. 35·20	35·06	12·85	37·79
		T	20·110 E.	Moon II.	13. 2. 54·44	54·25	..	[37·89]
			18·093 E.	Polaris S.P.	13. 17. 2·91	41·69	19·42	37·73
			20·110 E.	ζ Virginis	13. 27. 41·96	41·77	19·68	37·91
			,,	*m* Virginis	13. 34. 25·60	25·41	3·22	37·81
			,,	k^1 Centauri	13. 43. 59·10	58·90	36·86	37·96
			,,	η Boötis	13. 48. 6·44	6·26	44·27	38·01
			,,	τ Virginis	13. 54. 39·46	39·27	17·22	37·95
			,,	κ Virginis	14. 4. 35·92	35·74	13·67	37·93
			,, [20·111]	Arcturus	14. 9. 20·14	19·96	57·76	37·80
	27	R	20·110 E.	η Geminorum	6. 6. 43·32	43·13	21·05	37·92
			20·000 E.	δ Ursæ Minoris S.P.	6. 11. 49·80	43·19	20·31	37·12
			20·500 E.	Cephei 51	6. 41. 35·80	4·61	41·68	37·07
			20·110 E.	θ Canis Majoris	6. 47. 46·34	46·17	24·09	37·92
		T	20·462 W.	Polaris S.P.	13. 12. 34·67	40·95	18·14	37·19
			20·110 W.	Spica	13. 17. 58·64	58·56	36·73	38·17
			,,	ζ Virginis	13. 27. 41·62	41·53	19·71	38·18
			,,	*m* Virginis	13. 34. 25·14	25·06	3·26	38·20
			,,	1 Centauri	13. 37. 57·10	57·04	35·21	38·17
			,,	τ Boötis	13. 40. 41·66	41·55	19·69	38·14
			,,	κ^1 Centauri	13. 43. 58·64	58·58	36·90	38·32
			,,	Moon II.	13. 47. 16·22	16·14	..	[38·22]
			,,	Piazzi XIII. 264	13. 51. 59·98	59·87	38·10	38·23
			,,	κ Virginis	14. 5. 35·48	35·40	13·71	38·31
			,, [20·111]	Arcturus	14. 9. 19·64	19·53	57·79	38·26

January 25. ☽ 24^{s}·5, 38^{s}·8, 53^{s}·4, 8^{s}·0, 22^{s}·4.
,, 26. ☽ 25^{s}·3, 39^{s}·8, 54^{s}·5, 9^{s}·2, 23^{s}·3. Overcast; rain.
27. ☽ 46^{s}·7, 1^{s}·2, 16^{s}·2, 31^{s}·2, 45^{s}·9.

Day.		Observer.	Reading and Position of Micrometer. [Adopted Reading for Zero of Collimation.]	Object observed and (Number of Wires).	Mean observed Clock Time of Transit over the Center Wire.	Seconds of True Transit over the Meridian.	Seconds of Stars Assumed Apparent R. A.	Clock apparently Slow.
1875.			r		h m s	s	s	s
January	28	NO	16·896 E.	δ Ursæ Minoris S.P.	6. 15. 4·50	42·31	20·50	38·19
			20·110 E.	ν Geminorum (4)	6. 20. 55·06	54·91	33·58	38·67
			21·000 E.	Cephei 51	6. 42. 16·86	5·82	41·51	35·69
			20·110 E.	θ Canis Majoris	6. 47. 45·64	45·54	24·09	38·55
		T	20·110 W.	κ Virginis	14. 5. 35·06	34·98	13·74	38·76
			,,	Arcturus	14. 9. 19·24	19·11	57·83	38·72
			,,	f Boötis	14. 19. 59·92	59·79	38·75	38·96
			,,	ρ Boötis	14. 25. 48·08	47·95	26·79	38·84
			,,	Moon II.	14. 33. 6·12	6·06	..	[38·78]
			,,	ϵ^2 Boötis	14. 38. 53·08	52·93	31·78	38·85
			,,	ξ^2 Libræ	14. 49. 20·20	20·13	58·97	38·84
			,,	ψ Boötis (4)	14. 58. 26·51	26·36	5·34	38·98
			,,	ι^1 Libræ	15. 4. 26·80	26·75	5·49	38·74
			[20·111]					
	29	R	20·110 W.	η Geminorum	6. 6. 42·28	42·14	21·05	38·91
			20·000 W.	δ Ursæ Minoris S.P.	6. 11. 35·80	43·03	20·69	37·66
			19·500 W.	Cephei 51	6. 41. 50·60	2·50	41·35	38·85
			20·110 W.	θ Canis	6. 47. 45·18	45·05	24·09	39·04
		T	,,	α^2 Libræ	14. 43. 18·44	18·38	57·69	39·31
			,,	ξ^2 Libræ	14. 49. 19·86	19·80	59·07	39·27
			,,	ι^1 Libræ	15. 4. 26·24	26·18	5·59	39·41
			,,	β Libræ	15. 9. 37·40	37·34	16·54	39·20
			,,	Moon II.	15. 21. 23·06	23·01	..	[39·28]
			,,	α Coronæ	15. 28. 44·34	44·25	23·51	39·26
			,,	α Serpentis	15. 37. 27·16	27·08	6·31	39·23
			[20·111]					
	30	NO	20·110 E.	η Geminorum	6. 6. 41·60	41·54	21·04	39·50
			20·000 E.	δ Ursæ Minoris S.P.	6. 11. 44·60	40·45	20·86	40·41
			20·000 E.	Cephei 51	6. 40. 57·80	2·90	41·21	38·31
			20·110 E.	θ Canis	6. 47. 44·44	44·48	24·09	39·61
		T	,,	β Libræ	15. 9. 36·80	36·83	16·58	39·75
			,,	o^2 Libræ (4)	15. 15. 23·42	23·47	3·18	39·71
			,,	ζ^1 Libræ	15. 20. 32·38	32·43	12·16	39·73
			,,	α Coronæ	15. 28. 43·92	43·78	23·55	39·77
			,,	α Serpentis	15. 37. 26·68	26·64	6·34	39·70
			,,	ε Serpentis	15. 43. 54·94	54·91	34·73	39·82
			,,	γ Serpentis	15. 50. 0·74	0·66	40·42	39·76
			,,	β^1 Scorpii	15. 57. 29·64	29·71	9·60	39·89
			,,	δ Ophiuchi	16. 7. 7·46	7·46	47·14	39·68
			,,	Moon II.	16. 12. 51·18	51·27	..	[39·76]
			,,	Antares	16. 21. 4·02	4·13	43·90	39·77
			[20·111]					

January 28. ☽ 36ˢ·0, 50ˢ·7, 6ˢ·1, 21ˢ·5, 36ˢ·4.
" 29. ☽ 52ˢ·0, 7ˢ·2, 23ˢ·0, 38ˢ·9, 54ˢ·3. After sunrise. Limb steady and bright.
" 30. ☽ 19ˢ·0, 35ˢ·0, 51ˢ·2, 7ˢ·4, 23ˢ·2. An hour after sunrise. Limb steady and bright.

Day.	Observer.	Reading and Position of Micrometer. [Adopted Reading for Zero of Collimation.]	Object observed and (Number of Wires).	Mean observed Clock Time of Transit over the Center Wire.	Seconds of True Transit over the Meridian.	Seconds of Stars Assumed Apparent R. A.	Clock apparently Slow.
1875.		r		h m s	s	s	s
January 31	R	19·750 E.	δ Ursæ Minoris S.P.	6. 12. 3·33	41·55	21·03	39·48
		20·110 E.	β Canis Majoris	6. 16. 33·00	32·97	12·81	39·84
		20·750 E.	Cephei 51	6. 41. 53·33	2·13	41·07	38·94
		20·110 E.	θ Canis Majoris	6. 47. 44·20	44·15	24·09	39·94
		,,	ε Canis Majoris	6. 53. 4·20	4·18	44·05	39·87
		,,	γ Canis Majoris	6. 57. 27·60	27·56	7·39	39·83
		,,	51 Geminorum	7. 5. 32·98	32·90	12·86	39·96
		,, [20·111]	Moon II.	17. 7. 46·04	45·95	..	[40·09]
February 6	NO	20·500 W.	δ Ursæ Minoris S.P.	6. 12. 6·80	40·49	22·18	41·69
		20·110 W.	ν Geminorum	6. 20. 50·66	50·41	33·54	43·13
		,,	γ Geminorum	6. 29. 47·82	47·57	30·50	42·93
		19·500 W. [20·110]	Cephei 51	6. 41. 44·00	57·78	40·11	42·33
7	NO	21·917 W.	ε Ursæ Minoris S.P.	4. 58. 53·83	3·47	..	..
		? 20·090 W.	Rigel	5. 7. 49·44	49·19	32·56	43·37
		20·110 W.	β Tauri	5. 17. 40·76	40·62	24·35	43·73
		,,	δ Orionis	5. 24. 54·42	54·24	83·04	43·80
	T	20·110 W.	δ Ursæ Minoris S.P.	6. 11. 37·55	37·19	22·43	45·24
		,,	Cephei 51	6. 40. 57·34	56·72	39·86	42·14
		20·858 W.	λ Ursæ Minoris S.P.	7. 49. 34·60	9·53	54·83	45·30
	R	20·750 W. [20·110]	Polaris S.P.	13. 12. 58·20	21·50	8·73	47·23
8	T	20·110 W.	γ^1 Eridani	3. 51. 28·20	27·94	12·19	44·25
		,,	o^1 Eridani	4. 5. 2·28	2·01	46·23	44·22
			ε Ursæ Minoris S.P.	4. 58. 2·32	3·29	..	..
		20·000 ,,	δ Ursæ Minoris S.P.	6. 11. 29·80	39·35	22·71	43·36
	R	22·688 W.	λ Ursæ Minoris S.P.	7. 55. 39·40	10·85	55·23	44·38
		19·667 W. [20·110]	Polaris S.P.	13. 10. 7·17	22·24	7·86	45·62
9	R	20·110 W.	o^1 Eridani	4. 5. 1·60	1·38	46·22	44·84
		,,	γ Tauri	4. 11. 56·58	56·35	41·20	44·85
		20·000 W.	δ Ursæ Minoris S.P.	6. 11. 29·00	37·92	23·00	45·08
	NI	19·142 W.	Cephei 51	6. 42. 11·50	53·42	38·99	45·57
		18·600 W.	λ Ursæ Minoris S.P. (4)....	7. 42. 2·88	14·49	55·71	41·22
	T	20·287 W.	Polaris S.P.	13. 11. 40·00	23·28	7·06	43·78
		20·321 W.	α Serpentis	15. 37. 20·54	21·34	6·67	45·33
		20·110 W. [20·110]	ε Serpentis	15. 43. 49·72	49·74	35·05	45·31

January 31. ☽ II. $13^s{\cdot}1$, $29^s{\cdot}2$, $46^s{\cdot}0$, $2^s{\cdot}8$, $19^s{\cdot}0$. Two hours after sunrise. Tremor.

TABLE V.—ERRORS and RATES of the TRANSIT-CLOCK.

1874.		Observer.	Number of Clock Stars observed.	Sidereal Time.	Clock Slow, corrected for Personal Equation.	Clock's Loss in 24^h. Sidereal.	Adopted Losing Rate.
				h m	s	s	s
October	3	T	9	20. 55	+ 4·36	..	+ 11·52
		NO	4	1. 14	6·17		
	4	R	4	1. 27	17·89	+ 11·52	11·25
	5	R	8	20. 39	26·79	10·98	11·00
		NO	4	0. 55	28·60		
	6	T	10	20. 51	1·47	..	1·85
		R	5	2. 20	1·93		
	7	NI	9	21. 5	3·39	1·90	1·90
		R	8	23. 26	3·62		
	8	T	5	22. 52	5·40	1·89	1·91
		R	5	2. 26	5·76		
		NO	1	5. 42	6·45		
	9	NO	5	23. 9	7·49	1·94	1·88
		T	5	1. 46	7·56		
		R	2	7. 3	7·95		
	11	NI	7	0. 30	11·10	1·81	1·60
		R	2	7. 2	11·71		
	14	T	8	0. 40	15·39	1·40	1·76
	15	NO	8	0. 14	17·41	2·12	1·67
		T	7	6. 51	18·11		
	16	R	3	1. 44	18·89	1·22	1·74
	17	T	8	20. 9	20·84	2·26	2·29
		NO	8	0. 28	20·54		
		R	7	6. 32	21·90		
	18	T	3	20. 10	22·98	2·32	1·96
		T	6	2. 29	23·52		
	19	NO	8	22. 3	24·76	1·59	1·80
	20	R	3	22. 48	26·92	2·02	1·94
		NO	1	1. 39	26·92		
	21	T	7	22. 31	28·61	1·85	1·79
		NO	4	6. 37	29·38		
	22	NO	6	23. 39	30·44	1·73	1·76
		T	5	1. 49	30·74		
		R	2	6. 15	30·96		
	23	T	7	0. 36	32·36	1·79	1·79
	24	NO	4	0. 55	34·17	1·80	1·81
		R	2	6. 51	34·66		
	25	NO	3	1. 25	35·90	1·83	1·88
		R	3	2. 11	36·26		
	26	NO	9	3. 15	38·10	+ 1·94	+ 1·81
		R	6	6. 46	+ 38·46		

1874.		Observer.	Number of Clock Stars observed.	Sidereal Time.	Clock Slow, corrected for Personal Equation.	Clock's Loss in 24^h. Sidereal.	Adopted Losing Rate.
				h m	s	s	s
October	27	R	7	2. 9	+ 39·77	+ 1·68	+ 2·00
		NO	6	5. 11	39·96		
	28	NO	1	0. 56	41·91	2·32	1·95
	29	R	6	2. 2	43·56	1·58	1·89
	30	T	7	2. 13	45·77	2·20	2·18
November	2	T	2	0. 4	52·08	2·16	2·16
	3	T	5	20. 12	53·93	+ 2·17	+ 2·17
		NO	8	0. 22	+ 54·25		
	4	R	4	6. 38	− 25·72	..	..
	5	R	2	1. 28	− 30·68	− 5·98	− 5·94
		NO	7	6. 51	− 31·61		
	6	NO	8	0. 31	− 36·16	− 5·91	− 5·91
		R	7	7. 15	− 37·71		
	7	R	4	1. 18	+ 2·78	..	− 0·18
		NO	2	6. 51	2·80		
	8	T	2	1. 37	2·54	− 0·18	− 0·20
		R	6	7. 11	2·63		
	9	R	8	1. 38	2·38	− 0·22	− 0·07
		NO	3	6. 47	2·45		
	10	NO	8	1. 7	2·46	+ 0·07	− 0·03
	11	R	7	1. 22	2·32	− 0·14	+ 0·10
	12	T	6	1. 42	2·71	+ 0·35	0·45
		R	8	7. 43	2·72		
	13	NO	8	0. 34	3·15	0·55	0·43
		T	7	7. 19	3·35		
	14	NO	8	0. 30	3·50	0·32	0·31
		R	6	7. 4	3·65		
	15	NO	8	21. 20	3·82	0·30	0·35
		R	6	1. 52	3·81		
	16	T	8	22. 27	4·20	0·41	0·40
		R	2	2. 44	4·33		
	17	NO	5	0. 37	4·65	0·40	0·40
*							
	22	T	11	2. 17	4·97	..	0·40
		NO	9	6. 44	5·10		
	23	NO	9	1. 22	5·36	0·43	0·40
		T	8	4. 46	5·49		
		R	7	7. 21	5·52		
	24	T	1	1. 33	5·78	0·37	0·32
	25	T	1	13. 19	6·18	0·27	0·36
	26	NO	10	0. 55	+ 6·40	+ 0·46	+ 0·50

* Four days heavy rain.

1874.		Observer.	Number of Clock Stars observed.	Sidereal Time.	Clock Slow, corrected for Personal Equation.	Clock's Loss in 24^h. Sidereal.	Adopted Losing Rate.
				h m	s	s	s
November	27	NO	9	1. 18	+ 6·91		
		R	7	7. 12	7·11	+ 0·53	+ 0·44
		T	7	9. 33	7·13		
	28	T	5	2. 19	7·41		
		NO	2	7. 29	7·50	0·35	0·31
		R	5	9. 52	7·34		
	29	R	8	2. 0	7·60	0·26	0·25
		T	5	10. 29	7·71		
	30	NO	1	1. 18	7·87	0·23	0·22
		R	3	6. 47	7·89		
December	1	T	7	2. 0	8·04	0·20	0·26
		NO	9	6. 44	8·13		
	2	R	10	6. 58	8·44	0·33	0·34
	3	T	8	1. 2	8·69	0·34	0·24
		NO	5	5. 32	8·77		
	4	NO	8	1. 31	8·77	0·15	0·30
		R	10	6. 36	9·00		
	5	R	5	1. 24	9·28	0·46	0·53
		NO	7	6. 38	9·41		
	6	T	7	1. 21	9·89	0·61	0·48
	7	R	8	1. 34	10·22	0·35	0·38
		NO	9	5. 27	10·33		
	8	NO	9	0. 58	10·67	0·41	0·30
		T	8	7. 49	10·72		
	9	NO	8	1. 1	10·86	0·18	0·25
		R	8	6. 43	10·88		
	10	R	3	1. 8	11·07	0·33	0·22
		NO	9	5. 27	11·26		
	11	NO	8	1. 14	11·30	0·11	0·21
		R	8	5. 31	11·32		
	12	R	6	0. 49	11·59	0·31	0·33
	13	T	9	2. 15	12·03	0·36	0·26
		R	8	5. 41	11·98		
	14	R	3	23. 7	11·99		
		R	6	1. 34	12·15	0·16	0·26
		NO	1	5. 18	12·43		
	15	NO	12	0. 4	12·44	0·36	0·25
		R	8	6. 34	12·63		
	16	R	7	0. 53	12·75	0·14	0·28
		NO	10	5. 48	12·59		
	17	NO	3	1. 25	13·05	0·42	0·46
		R	8	7. 13	13·18		
	18	R	8	1. 52	13·55	0·49	0·42
	19	NO	9	2. 39	13·83	+ 0·36	+ 0·51
		NO	3	6. 17	+ 14·16		

1874.		Observer.	Number of Clock Stars observed.	Sidereal Time.	Clock Slow, corrected for Personal Equation.	Clock's Loss in 24^h. Sidereal.	Adopted Losing Rate.
				h m	s	s	s
December	20	NO	10	3. 50	+ 14·55	+ 0·66	+ 0·61
	21	T	11	7. 19	15·25	0·56	0·56
	22	NO	3	6. 0	15·77	0·55	0·71
	23	NO	1	7. 33	16·70	0·87	0·80
	24	R	9	8. 6	17·45	0·73	0·68
	26	R	6	8. 6	18·69	0·62	0·76
	27	NO	9	5. 47	19·51	0·91	0·73
	29	R	4	0. 44	19·80		
		NO	8	6. 20	20·12	0·55	0·50
		T	6	13. 0	20·25		
	30	R	10	7. 6	20·53	0·46	0·38
		NO	7	12. 53	20·68		
	31	R	8	1. 0	20·72	0·30	0·39
		T	9	13. 17	20·99		
1875.							
January	1	NO	9	6. 38	21·32	0·48	0·44
		T	9	14. 10	21·47		
	2	R	8	6. 36	21·68	0·39	0·44
		T	5	14. 19	21·93		
	3	R	4	13. 45	22·34	0·48	0·70
	4	T	6	3. 47	22·85	0·93	1·00
		R	8	12. 52	23·28		
	5	R	8	6. 36	24·05	1·07	1·02
	6	T	8	6. 48	25·02	0·98	0·98
		R	7	13. 0	25·29		
	7	T	1	0. 56	25·64	0·99	0·98
		T	8	13. 36	26·35		
	8	R	9	4. 28	26·94	0·98	0·95
		T	8	13. 47	27·27		
	9	T	9	7. 2	27·90	0·92	0·88
		R	9	13. 9	28·21		
	10	R	8	6. 56	28·78	0·84	0·81
		T	11	13. 49	29·04		
	11	T	4	1. 8	29·32		
		R	7	6. 31	29·48	0·78	0·84
		T	8	13. 39	29·93		
	12	R	12	13. 36	30·73	0·90	0·82
	13	T	6	1. 6	31·04	0·75	0·86
		R	11	13. 27	31·51		
	14	R	7	2. 14	32·03	0·96	0·79
	15	R	10	3. 21	32·65	0·62	0·66
		R	6	13. 39	32·99		
	16	R	9	4. 27	33·39	0·69	0·55
	17	R	5	6. 25	+ 33·83	+ 0·41	+ 0·48

1875.		Observer.	Number of Clock Stars observed.	Sidereal Time.	Clock Slow, corrected for Personal Equation.	Clock's Loss in 24^h. Sidereal.	Adopted Losing Rate.
				h m	s	s	s
January	18	NI	1	1. 35	+34·10	+0·54	+0·60
		R	8	6. 12	34·42		
	19	T	5	1. 28	34·82	0·65	0·55
		T	10	6. 46	34·97		
	20	T	1	1. 3	35·28	0·45	0·43
		R	11	7. 13	35·40		
	21	T	10	8. 42	35·83	0·41	0·42
	22	T	1	7. 56	36·22	0·44	0·37
		R	8	10. 53	36·33		
	23	R	7	6. 57	36·60	0·30	0·38
		NO	7	10. 51	36·55		
	24	NO	1	6. 31	36·92	0·46	0·42
		R	10	12. 7	37·12		
	25	T	11	12. 55	37·47	0·37	0·40
	26	NO	8	6. 36	37·78	0·42	0·36
		T	8	13. 50	37·91		
	27	R	8	6. 27	38·06	0·30	0·46
		T	9	13. 44	38·22		
	28	NO	9	6. 52	38·68	0·61	0·54
		T	8	14. 34	38·84		
	29	R	8	6. 27	39·15	0·46	0·46
		T	6	15. 9	39·28		
	30	NO	8	6. 24	39·58	0·45	0·49
		T	10	15. 42	39·76		
	31	R	8	6. 42	40·10	0·53	0·50
February	1	R	8	6. 27	40·57	0·48	0·52
	2	NO	8	7. 36	41·14	0·55	0·58
	3	NO	9	7. 4	41·75	0·62	0·53
	6	NO	2	6. 26	43·07	0·44	0·54
	7	NO	3	5. 18	43·67	0·63	0·62
	8	T	2	3. 59	44·24	0·60	0·68
	9	R	2	4. 9	45·06	+ 0·76	+ 0·76
		T	2	15. 41	+45·32		

TABLE VI.—COMPARISONS of the ALTAZIMUTH-CLOCK at HONOLULU with the TRANSIT-CLOCK by the Intervention of a MEAN-TIME HALF-SECONDS CHRONOMETER and Inferred ERRORS and RATES of the ALTAZIMUTH-CLOCK.

Day.	Observer.	Time by Transit-Clock at Comparison with Chronometer.	Time by Chronometer at Comparison with		Time by Altazimuth-Clock at Comparison with Chronometer.	Altazimuth-Clock slow on Apua Sidereal Time.	Hourly Rate of Altazimuth-Clock.
			Transit-Clock.	Altazimuth-Clock.			
1874.		h m s	h m s	h m s	h m s	s	s
October 2	NI	20. 53. 35	8. 9. 40·5	8. 21. 5·0	21. 6. 40	+33·63	+ 3·14
		0. 46. 9	12. 1. 40·5	12. 11. 35·5	0. 57. 37	+45·72	
3	NI	20. 31. 1	7. 41. 6·0	7. 45. 0·5	20. 35. 54	−53·82	+ 1·52
		23. 10. 15	10. 19. 55·0	10. 11. 30·0	23. 2. 44	−50·07	
	T	5. 2. 15	4. 11. 0·0	4. 13. 40·5	5. 5. 45	−40·94	+ 1·54
		6. 34. 54	5. 43. 24·5	5. 39. 40·5	6. 31. 57	−38·74	
4	NI	5. 19. 44	4. 24. 40·5	4. 30. 22·0	5. 25. 50	− 3·82	+ 1·47
		6. 33. 35	5. 38. 20·0	5. 34. 55·0	6. 30. 32	− 2·23	
5	T	21. 21. 24	8. 23. 50·0	8. 26. 35·0	21. 24. 16	+20·48	+ 1·51
		23. 17. 10	10. 19. 18·0	10. 15. 8·0	23. 13. 4	23·23	
	NI	4. 27. 56	3. 29. 15·5	3. 45. 55·0	4. 44. 37	31·53	+ 1·47
		6. 23. 24	5. 24. 25·5	5. 19. 15·0	6. 18. 10	33·82	
6	NI	20. 55. 20	7. 53. 29·0	8. 12. 40·0	21. 13. 57	38·65	+ 1·50
		23. 5. 4	10. 2. 52·0	9. 57. 25·5	22. 58. 57	41·27	
7	T	5. 58. 14	4. 51. 1·5	4. 56. 4·5	6. 1. 54	87·94	+ 1·47
		7. 9. 40	6. 2. 16·0	5. 57. 47·0	7. 3. 45	89·46	
15	T	21. 39. 8	8. 2. 0·5	9. 4. 15·5	22. 41. 18	32·65	+ 0·16
		22. 46. 40	9. 9. 21·5	9. 7. 15·0	22. 44. 18	32·57	
16	NI	22. 42. 39	9. 1. 25·5	9. 6. 40·5	22. 47. 37	36·53	+ 0·21
		0. 35. 17	10. 53. 45·0	10. 48. 10·0	0. 29. 23	36·89	
17	NI	23. 36. 8	9. 50. 50·0	9. 56. 10·0	23. 41. 8	41·82	+ 0·23
		0. 52. 56	11. 7. 25·5	11. 4. 25·0	0. 49. 34	42·08	
18	T	0. 32. 47	10. 43. 25·5	10. 58. 35·0	0. 47. 35	47·33	+ 0·20
		1. 53. 15	0. 3. 40·5	0. 1. 5·0	1. 50. 15	47·53	
19	NI	23. 22. 44	9. 27. 40·0	9. 34. 55·0	23. 27. 33	51·72	+ 0·21
		1. 22. 59	11. 29. 35·5	11. 24. 0·5	1. 16. 56	52·09	
21	NI	22. 56. 33	8. 55. 45·5	8. 58. 55·0	22. 59. 10	61·73	+ 0·21
		23. 42. 50	9. 41. 55·0	9. 36. 25·0	23. 36. 46	61·86	+ 0·07
	NI	1. 24. 12	11. 23. 0·5	11. 28. 0·0	1. 28. 39	62·01	+ 0·27
		3. 46. 5	1. 44. 30·5	1. 38. 35·0	3. 39. 35	+62·60	

October 3, noon. Altazimuth-Clock stopped to adjust pendulum.

October 6. Altazimuth-Clock, having run down, was wound and set going at 8^h mean time. October 8. Pendulum adjusted.

Day.		Observer.	Time by Transit-Clock at Comparison with Chronometer.	Time by Chronometer at Comparison with Transit-Clock.	Time by Chronometer at Comparison with Altazimuth-Clock.	Time by Altazimuth-Clock at Comparison with Chronometer.	Altazimuth-Clock slow on Apua Sidereal Time.	Hourly Rate of Altazimuth-Clock.
1874.			h m s	h m s	h m s	h m s	s	s
October	22	NI	3. 21. 5	1. 15. 40·0	1. 20. 35·5	3. 25. 25	+ 67·08	+ 0·19
			6. 1. 11	3. 55. 20·0	3. 46. 40·0	5. 51. 53	67·54	
	23	T	2. 53. 30	0. 44. 14·5	0. 47. 43·0	2. 56. 20	71·60	0·17
			4. 29. 10	2. 19. 39·0	2. 14. 45·0	4. 23. 36	71·84	
	24	NI	3. 52. 15	1. 38. 55·5	1. 44. 45·5	3. 57. 24	76·36	0·22
			5. 40. 2	3. 26. 25·0	3. 21. 20·0	5. 34. 14	76·71	
	25	T	5. 0. 50	2. 43. 25·5	2. 48. 36·5	5. 5. 17	81·18	0·20
			7. 7. 37	4. 49. 52·0	4. 47. 20·5	7. 4. 20	81·58	
	26	T	0. 32. 55	10. 12. 20·0	10. 17. 1·5	0. 36. 50	85·22	0·16
			2. 27. 10	12. 6. 16·5	11. 59. 35·0	2. 19·40	85·49	
		NI	5. 29. 53	3. 8. 30·0	3. 13. 5·0	5. 33. 41	86·08	0·19
			7. 23. 57	5. 2. 15·5	4. 58. 55·0	7. 19. 48	86·41	
	27	T	1. 44. 25	11. 19. 44·5	11. 22. 59·0	1. 46. 50	89·73	0·21
			2. 46. 10	0. 21. 19·5	0. 16. 5·5	2. 40. 5	89·92	
		NI	5. 35. 48	3. 10. 30·0	3. 16. 10·5	5. 40. 39	90·45	0·20
			8. 19. 30	5. 53. 45·5	5. 48. 50·0	8. 13. 43	90·94	
	28	NI	2. 20. 45	11. 52. 5·0	11. 58. 0·0	2. 25. 48	94·69	0·19
			4. 27. 21	1. 58. 20·5	1. 53. 20·5	4. 21. 27	95·07	
	29	NI	3. 31. 15	0. 58. 30·5	1. 4. 0·5	3. 35. 50	99·58	0·18
			6. 12. 26	3. 39. 15·5	3. 34. 0·5	6. 6. 14	100·03	
November	3	T	23. 7. 30	8. 15. 12·0	8. 20. 45·5	23. 12. 0	118·61	0·15
			0. 46. 38	9. 54. 3·5	9. 42. 12·0	0. 33. 40	118·80	
	4	T	8. 1. 45	5. 2. 34·0	5. 15. 14·5	8. 11. 57	124·58	+ 0·17
			9. 51. 30	6. 52. 0·0	6. 45. 16·5	9. 42. 14	+ 124·83	
	5	NI	8. 3. 41	5. 0. 20·0	5. 4. 30·5	8. 7. 25	− 4·83	− 0·01
			9. 13. 18	6. 9. 45·0	6. 6. 45·0	9. 9. 50	− 4·84	
	6	NI	23. 42. 49	8. 36. 45·0	8. 41. 55·0	23. 47. 28	− 4·02	+ 0·03
			2. 35. 59	11. 29. 25·0	11. 24. 35·5	2. 30. 36	− 3·94	
	9	NI	0. 7. 45	8. 50. 5·0	8. 56. 10·0	0. 13. 54	− 0·56	+ 0·04
			2. 9. 16	10. 51. 15·5	10. 46. 5·5	2. 4. 8	− 0·48	
	10	NI	23. 23. 1	8. 1. 25·5	8. 6. 5·0	23. 27. 43	+ 0·75	+ 0·06
			0. 51. 50	9. 29. 59·5	9. 26. 15·5	0. 48. 7	0·83	
	11	NI	0. 3. 30	8. 37. 45·0	8. 43. 20·5	0. 9. 7	1·77	+ 0·05
			2. 8. 6	10. 42. 0·0	10. 36. 20·5	2. 2. 26	+ 1·86	

November 5, noon. Adjusted pendulum of Altazimuth-Clock.

Day.		Observer.	Time by Transit-Clock at Comparison with Chronometer.	Time by Chronometer at Comparison with		Time by Altazimuth-Clock at Comparison with Chronometer.	Altazimuth-Clock slow on Apua Sidereal Time.	Hourly Rate of Altazimuth-Clock.
				Transit-Clock.	Altazimuth-Clock.			
			h m s	h m s	h m s	h m s	s	s
1874. November	12	NI	0. 0. 2	8. 30. 15·5	8. 33. 10·5	0. 2. 57	+3·13	+ 0·06
			2. 8. 13	10. 38. 5·0	10. 35. 35·0	2. 5. 42	3·25	
	13	NI	0. 1. 58	8. 28. 10·0	8. 33. 20·0	0. 7. 8	4·05	0·02
			1. 55. 27	10. 21. 20·0	10. 17. 40·5	1. 51. 46	4·09	
	14	NI	0. 4. 25	8. 26. 35·0	8. 31. 20·5	0. 9. 10	4·82	0·07
			1. 36. 21	9. 58. 15·5	9. 51. 40·0	1. 29. 43	4·92	
	15	NI	0. 35. 22	8. 53. 25·0	8. 58. 55·0	0. 40. 51	5·75	0·10
			2. 16. 24	10. 34. 10·0	10. 25. 25·5	2. 7. 36	5·89	
	16	NI	1. 27. 7	9. 41. 0·0	9. 44. 55·5	1. 31. 1	6·41	0·05
			3. 29. 28	11. 43. 0·5	11. 38. 15·5	3. 24. 40	6·50	
	17	NI	22. 32. 24	6. 42. 45·0	6. 53. 46·5	22. 43. 25	6·98	0·03
	22	NI	3. 40. 3	11. 29. 15·5	11. 38. 40·0	3. 49. 23	11·12	0·00
			5. 56. 21	1. 45. 10·5	1. 40. 20·5	5. 51. 24	11·23	
	23	NI	3. 48. 26	11. 33. 35·0	11. 38. 5·0	3. 52. 50	12·21	0·03
			7. 5. 59	2. 50. 35·0	2. 46. 30·5	7. 1. 47	12·31	
	26	NI	4. 25. 27	11. 58. 25·5	12. 3. 50·0	4. 30. 42	16·88	0·02
			5. 40. 14	1. 13. 0·0	1. 9. 25·0	5. 36. 28	16·90	
	27	NI	4. 45. 26	12. 14. 20·0	12. 18. 30·5	4. 49. 26	18·24	0·03
			7. 5. 55	2. 34. 25·5	2. 26. 55·0	6. 58. 12	18·31	
	28	NI	4. 13. 48	11. 38. 45·5	11. 45. 15·5	4. 20. 7	19·47	0·05
			6. 3. 56	1. 28. 35·0	1. 23. 30·0	5. 58. 38	19·55	
	29	NI	6. 40. 59	2. 1. 30·0	2. 10. 0·0	6. 49. 17	21·09	0·07
			8. 40. 9	4. 0. 20·0	3. 54. 35·5	8. 34. 10	21·22	
December	1	NI	7. 15. 9	2. 27. 30·5	2. 33. 20·5	7. 20. 44	24·10	0·04
			9. 11. 18	4. 23. 20·0	4. 17. 40·0	9. 5. 21	24·17	
	2	NI	8. 34. 24	3. 42. 30·0	3. 46. 50·5	8. 38. 28	25·70	0·04
			10. 18. 42	5. 26. 30·5	5. 22. 10·5	10. 14. 4	25·76	
	4	NI	9. 32. 28	4. 32. 20·0	4. 38. 10·0	9. 38. 0	27·95	0·02
			10. 53. 2	5. 52. 40·5	5. 46. 45·5	10. 46. 47	27·97	
	6	T	17. 16. 33	0. 11. 0·5	0. 54. 30·0	17. 59. 50	29·21	
			18. 6. 35	1. 0. 54·5	0. 57. 34·5	18. 2. 55	29·17	+ 0·03
	7	T	17. 13. 10	0. 3. 46·0	0. 18. 3·5	17. 27. 10	29·94	
			17. 57. 6	0. 47. 35·0	0. 43. 4·5	17. 52. 15	+29·90	

Day.		Observer.	Time by Transit-Clock at Comparison with Chronometer.	Time by Chronometer at Comparison with		Time by Altazimuth-Clock at Comparison with Chronometer.	Altazimuth-Clock slow on Apua Sidereal Time.	Hourly Rate of Altazimuth-Clock.
				Transit-Clock.	Altazimuth-Clock.			
			h m s	h m s	h m s	h m s	s	s
1874. December	8	T	17. 6. 38	11. 56. 31·5	0. 10. 1·5	17. 19. 50	+30·68	
			17. 47. 10	0. 36. 57·0	0. 35. 7·5	17. 45. 0	30·72	+ 0·06
			21. 57. 35	4. 54. 52·5	5. 3. 29·5	22. 5. 53	30·98	
			22. 16. 6	5. 13. 20·5	5. 6. 38·0	22. 9. 2	30·99	
	13	T	17. 59. 30	0. 29. 56·5	1. 10. 42·5	18. 40. 0	34·44	..
			18. 52. 12	1. 22. 30·0	1. 13. 45·0	18. 43. 3	34·45	
	14	NI	0. 59. 48	7. 25. 15·5	7. 31. 50·0	1. 6. 0	35·70	0·05
			2. 48. 30	9. 13. 40·0	9. 8. 10·5	2. 42. 36	35·78	
	15	NI	2. 2. 30	8. 23. 56·0	8. 29. 25·0	2. 7. 36	36·40	0·02
			3. 48. 26	10. 9. 35·0	10. 5. 50·5	3. 44. 17	36·43	
	18	NI	4. 30. 48	10. 40. 15·0	10. 45. 20·0	4. 35. 29	38·42	0·02
			5. 58. 7	12. 7. 20·0	12. 0. 0·0	5. 50. 21	38·44	
	19	NI	5. 11. 11	11. 16. 40·0	11. 23. 15·0	5. 17. 22	39·04	0·02
			6. 44. 31	12. 49. 45·0	12. 43. 55·0	6. 38. 15	39·06	
	20	NI	7. 12. 37	1. 13. 55·0	1. 20. 25·0	7. 18. 43	39·74	0·01
			8. 30. 14	2. 31. 19·5	2. 28. 23·0	8. 26. 53	(38·75)	
	21	NI	7. 41. 6	1. 38. 28·0	1. 44. 15·0	7. 46. 29	40·19	0·05
			8. 52. 25	2. 49. 35·5	2. 43. 10·5	8. 45. 34	40·24	
	22	T	3. 49. 0	9. 43. 8·0	9. 47. 37·0	3. 53. 5	40·44	0·00
			5. 15. 50	11. 9. 44·0	11. 4. 39·5	5. 10. 20	40·44	
	24	NI	4. 27. 26	10. 13. 45·0	10. 18. 25·0	4. 31. 43	41·11	0·01
			5. 35. 37	11. 21. 45·0	11. 17. 5·5	5. 30. 33	41·12	
	26	NI	6. 41. 18	12. 19. 33·0	12. 22. 30·5	6. 44. 53	41·62	+ 0·01
			8. 2. 21	1. 40. 23·0	1. 33. 50·0	7. 55. 24	41·63	
	27	T	18. 42. 42	0. 19. 1·0	0. 26. 43·5	18. 50. 3	41·84	
	29	NI	7. 21. 7	0. 47. 42·5	0. 52. 35·0	7. 25. 38	42·38	− 0·02
			8. 54. 50	2. 21. 10·5	2. 16. 25·5	8. 49. 42	42·35	
	30	NI	9. 5. 58	2. 28. 25·5	2. 34. 5·0	9. 11. 16	42·99	− 0·13
			10. 34. 17	3. 56. 30·5	3. 51. 38·5	10. 29. 2	42·82	
	31	NI	9. 30. 0	2. 48. 32·0	2. 52. 41·0	9. 33. 47	43·57	+ 0·01
			11. 6. 24	4. 24. 40·5	4. 19. 25·0	11. 0. 45	43·58	
1875. January	1	NI	9. 58. 39	3. 13. 15·5	3. 19. 15·5	10. 4. 17	44·36	0·00
			11. 25. 48	4. 40. 10·5	4. 33. 37·5	11. 18. 51	+44·36	

Day.		Observer.	Time by Transit-Clock at Comparison with Chronometer.	Time by Chronometer at Comparison with Transit-Clock.	Time by Chronometer at Comparison with Altazimuth-Clock.	Time by Altazimuth-Clock at Comparison with Chronometer.	Altazimuth-Clock slow on Apua Sidereal Time.	Hourly Rate of Altazimuth-Clock.
1875.			h m s	h m s	h m s	h m s	s	s
January	3	T	19. 46. 57	0. 56. 7·5	0. 50. 59·5	19. 41. 25	+45·17	
	7	NI	6. 56. 54	11. 48. 50·0	11. 53. 0·5	7. 0. 42	49·21	+ 0·02
			9. 4. 20	1. 55. 55·5	1. 50. 35·5	8. 58. 36	49·25	
	8	NI	3. 45. 15	8. 33. 50·5	8. 39. 13·5	3. 50. 16	49·76	0·00
			6. 59. 1	11. 47. 5·5	11. 42. 23·0	6. 53. 55	49·75	
	11	T	2. 29. 25	6. 46. 5·0	6. 48. 25·5	2. 31. 24	51·30	+ 0·04
			4. 14. 50	8. 31. 13·0	8. 27. 25·5	4. 10. 40	51·37	
	13	NI	3. 49. 41	7. 58. 25·0	8. 2. 27·5	3. 53. 23	52·31	− 0·08
			5. 14. 35	9. 23. 5·5	9. 20. 0·0	5. 11. 8	52·20	
	14	NI	4. 25. 13	8. 30. 0·5	8. 34. 55·5	4. 29. 48	52·90	+ 0·05
			6. 8. 7	10. 12. 38·0	10. 8. 22·5	6. 3. 30	52·97	
	15	T	4. 12. 5	8. 13. 3·5	8. 25. 17·0	4. 24. 0	53·17	0·00
			6. 31. 36	10. 32. 12·0	10. 28. 37·0	6. 27. 40	53·18	
	16	NI	6. 2. 46	9. 59. 35·5	10. 7. 55·5	6. 10. 47	53·77	+ 0·05
			7. 45. 37	11. 42. 10·0	11. 38. 15·0	7. 41. 21	53·84	
	17	NI	5. 20. 25	9. 13. 30·5	9. 17. 25·5	5. 24. 0	54·44	+ 0·03
			6. 28. 56	10. 21. 50·5	10. 16. 28·0	6. 23. 12	54·47	
	18	NI	3. 9. 49	6. 59. 25·5	7. 7. 30·0	3. 17. 34	55·09	− 0·15
			4. 32. 32	8. 21. 55·5	8. 16. 13·0	4. 26. 28	54·91	
	19	NI	3. 28. 0	7. 13. 43·0	7. 16. 13·5	3. 30. 10	55·78	− 0·09
			4. 53. 28	8. 38. 57·5	8. 34. 15·0	4. 48. 24	55·66	+ 0·06
		T	10. 45. 10	2. 29. 43·0	2. 32. 40·5	10. 47. 47	56·03	+ 0·01
			12. 14. 53	3. 59. 11·5	3. 52. 45·5	12. 8. 5	56·05	
	20	T	4. 22. 5	7. 42. 19·5	7. 47. 50·0	4. 27. 15	56·73	+ 0·05
			6. 2. 4	9. 22. 2·5	9. 15. 25·0	5. 55. 4	56·81	+ 0·06
		NI	9. 24. 49	0. 44. 15·0	0. 50. 55·5	9. 31. 9	57·02	+ 0·02
			11. 32. 47	2. 51. 52·5	2. 43. 0·5	11. 23. 32	57·06	
	21	T	5. 29. 40	8. 45. 53·0	8. 50. 14·5	5. 33. 40	57·99	+ 0·04
			7. 12. 40	10. 28. 36·5	10. 23. 59·5	7. 7. 40	58·05	
	22	T	8. 0. 45	11. 12. 43·0	11. 16. 25·5	8. 4. 5	59·37	+ 0·03
			9. 24. 54	12. 36. 38·5	12. 31. 8·5	9. 19. 0	59·41	
	23	NI	5. 57. 49	9. 6. 15·5	9. 12. 31·5	6. 3. 42	60·54	+ 0·04
			7. 34. 21	10. 42. 32·0	10. 36. 34·0	7. 27. 58	+60·60	

Day.		Observer.	Time by Transit-Clock at Comparison with Chronometer.	Time by Chronometer at Comparison with		Time by Altazimuth-Clock at Comparison with Chronometer.	Altazimuth-Clock slow on Apua Sidereal Time.	Hourly Rate of Altazimuth-Clock.
				Transit-Clock.	Altazimuth-Clock.			
1875.			h m s	h m s	h m s	h m s	s	s
January	24	NI	7. 32. 3	10. 36. 23·0	10. 39. 55·0	7. 35. 11	+61·59	+ 0·01
			9. 5. 32	12. 9. 37·0	12. 3. 45·5	8. 59. 15	61·60	
	25	NI	8. 16. 59	11. 17. 20·5	11. 26. 20·0	8. 25. 35	62·33	+ 0·05
			9. 59. 45	12. 59. 50·0	12. 53. 31·0	9. 53. 0	62·40	
	27	NI	9. 0. 58	11. 53. 30·0	11. 58. 53·5	9. 5. 56	64·48	+ 0·04
			10. 43. 41	1. 35. 56·5	1. 29. 7·0	10. 36. 24	64·54	
	28	NI	5. 18. 48	8. 8. 4·5	8. 13. 40·5	5. 23. 58	65·54	+ 0·04
			8. 25. 44	11. 14. 30·5	11. 11. 5·0	8. 21. 51	65·66	
	29	NI	4. 23. 51	7. 9. 25·0	7. 15. 55·5	4. 29. 55	66·65	+ 0·04
			6. 47. 12	9. 32. 23·0	9. 26. 47·5	6. 41. 8	66·74	
	30	NI	5. 52. 17	8. 33. 45·5	8. 42. 17·0	6. 0. 22	67·44	+ 0·07
			6. 45. 10	9. 26. 30·0	9. 22. 51·5	6. 41. 3	67·49	
	31	T	6. 33. 17	9. 39. 15·0	9. 43. 15·5	6. 36. 50	68·25	0·00
			7. 35. 40	10. 41. 28·0	10. 36. 7·0	7. 29. 50	68·25	
February	1	NI	6. 48. 8	9. 50. 12·5	9. 59. 5·5	6. 56. 34	69·01	+ 0·01
			7. 47. 20	10. 49. 15·0	10. 45. 40·0	7. 43. 16	69·02	
	2	NI	5. 55. 49	8. 54. 10·5	9. 0. 15·0	6. 1. 26	69·58	+ 0·07
			7. 23. 8	10. 21. 15·5	10. 12. 0·5	7. 13. 23	69·64	
						Time by Altaz. Clock.		
	5	T	By Zenith distance of δ Leonis, East, Table IX.			7. 59.	70·87	0·00
			” ”			8. 6.	71·30	
			” α Orionis, West.........			9. 30.	71·12	
			” ”			9. 37.	71·06	

TABLE VII.—CATALOGUE of the ASSUMED MEAN PLACES of STARS observed with the ALTAZIMUTH.

G refers to the Greenwich Catalogue for Epoch 1864; S to the Cape Catalogue for 1860; E to the First Melbourne Catalogue, 1870; R to the Second Radcliffe Catalogue, 1860. Preference is given to the later observations at Melbourne and Greenwich.

Star.	1874·0.		1875·0.		Seconds of Mean N. P. D. by various Authorities, and Number of Observations of N.P.D.
	R. A.	N. P. D.	R. A.	N. P. D.	
	h m s	° ′ ″	h m s	° ′ ″	
β Cassiopeiæ	0. 2. 27·81	31. 32. 43·5	....	....	G (1860) 6, 43″·4; R 3, 43″·8.
Bradley 24	0. 19. 5·83	10. 38. 45·1	....	....	G 17, 45″·1; G (1870) 1, 45″·1; (1869) 2, 45″·0; (1871) 3, 44″·5.
α Phœnicis	0. 20. 3·14	132. 59. 24·25	....	....	S 1, 25″·2; E 3, 23″·9.
13 Cassiopeiæ	0. 24. 11·96	24. 10. 36·6	....	....	G 6, 36″·3; R 4, 37″·1.
α Cassiopeiæ	0. 33. 22·05	34. 9. 14·65	....	....	G 21, 14″·5; R 6, 15″·3.
β Ceti	0. 37. 15·79	108. 40. 43·2	....	....	G 15, 44″·0; S 122, 43″·1; E 27, 43″·0.
21 Cassiopeiæ	0. 37. 21·92	15. 42. 4·1	....	....	G 15.
η^1 Cassiopeiæ	0. 41. 29·22	32. 51. 11·5	....	....	G 6, 11″·1; R 6, 12″·0.
μ Andromedæ	0. 49. 45·82	52. 11. 4·6	....	....	G 37.
2 Ursæ Minoris	0. 51. 54·05	4. 25. 12·5	....	....	G 10.
Polaris	1. 12. 38·29	1. 21. 45·2	....	....	G 930.
β Phœnicis	1. 0. 27·44	137. 23. 37·8	....	....	S 5, 38″·1; E 3, 37″·4.
β Andromedæ	1. 2. 40·92	55. 2. 52·6	....	....	G 16.
α Eridani	1. 33. 1·11	147. 52. 39·0	....	....	S 27, 39″·7; E 20, 38″·1.
ε Cassiopeiæ	1. 45. 20·96	26. 57. 5·9	....	....	G (1850) 8, 5″·2; B. A. C., 5″·2; R 5, 7″·1.
β Arietis	....	....	1. 47. 44·18	69. 48. 14·2	G 49.
46 Cassiopeiæ	1. 46. 14·47	21. 56. 6·7	....	....	G 25.
127 Eridani	1. 51. 3·11	142. 14. 11·8	....	....	S 2, 12″·1; E 3, 11″·5.
47 Cassiopeiæ	1. 52. 34·44	13. 19. 33·6	....	....	G 5, 33″·6; R 3, 33″·4.
α Arietis	2. 0. 4·38	67. 8. 4·4	....	....	G 57.
168 Eridani	2. 22. 21·94	138. 16. 12·9	....	....	S 7, 13″·2; E 3, 12″·0.
α Tauri	4. 28. 41·49	73. 44. 45·7	....	....	G 78.
υ^7 Eridani	....	....	4. 30. 41·48	120. 49. 9·5	G 12, (1869–72) 3, 8″·6; S 1, 11″·6.
ε Leporis	....	....	5. 0. 10·20	112. 32. 25·4	G 7, 26″·1; E 40, 25″·3; S 26, 25″·2.
α Aurigæ	5. 7. 22·99	44. 7. 58·6	....	....	G 35, 58″·6; R 9, 58″·7.
α Columbæ	....	....	5. 35. 7·42	124. 8. 30·7	G 7, 31″·2; E 45, 30″·9; S 39, 30″·3.
β Columbæ	....	....	5. 46. 33·19	125. 49. 1·0	G 4, 2″·5. S 5, 1″·3. E 4, 59″·3.
α Orionis	....	....	5. 48. 24·27	82. 37. 5·45	G 53.
45 Aurigæ	....	....	6. 11. 36·58	36. 29. 39·0	G 5, 38″·9. R 4, 39″·05.
Canopus	....	....	6. 21. 10·55	142. 37. 40·6	E 23, 41″·05; S 24, 40″·1.
γ Geminorum	6. 30. 25·90	73. 29. 43·0	....	....	G 36.
Sirius	....	....	6. 39. 38·29	106. 32. 46·9	G 65, 47″·3. S 68, 46″·6. E 53, 46″·9.
Cephei 51	6. 40. 44·90	2. 45. 52·5	....	....	G 222.
μ Canis Majoris	....	....	6. 50. 22·97	103. 53. 0·7	G 15, 0″·7. S 1, 1″·2.
ε Canis Majoris	....	....	6. 53. 42·80	118. 48. 11·8	G 7, 12″·1. S 70, 12″·0. E 50, 11″·6.
α Canis Minoris	7. 32. 42·31	84. 27. 15·0	....	....	G 61.

Star.	1874·0.		1875·0.		Seconds of Mean N. P. D. by various Authorities, and Number of Observations of N.P.D.
	R. A.	N. P. D.	R. A.	N. P. D.	
	h m s	° ′ ″	h m s	° ′ ″	
β Geminorum ...	....	....	7. 37. 39·86	61. 40. 25·75	G 49.
ξ Navis	....	....	7. 44. 2·22	114. 32. 49·85	G 2, 50″·0; S 2, 49″·7.
π Ursæ Majoris..	....	....	8. 29. 15·49	25. 14. 16·6	G 5, 17″·1; (1871–2) 7, 16″·2.
5 Ursæ Majoris..	....	....	8. 43. 3·61	27. 34. 18·8	G 3, 19″·1; R 5, 18″·6.
ι Ursæ Majoris ..	....	....	8. 50. 38·42	41. 28. 9·9	G 4, 10″·0. R 9, 9″·8.
ι Argûs	....	....	9. 13. 44·60	148. 45. 4·0	E 16, 3·″7. S 3, 5″·7.
Regulus	10. 1. 39·56	77. 25. 4·0	....	....	G 71.
γ¹ Leonis	10. 13. 1·36	69. 31. 19·3	....	....	G 27.
β Ursæ Majoris..	10. 54. 13·52	32. 56. 33·0	....	....	G (1869) 6, 32″·7; G (1870) 4, 33″·0; R 6, 33″·3.
δ Leonis	11. 7. 24·29	68. 47. 10·8	....	....	G 48.
β Leonis	....	....	11. 42. 40·94	74. 43. 45·4	G 38.
ο Virginis	11. 58. 47·43	80. 34. 1·9	....	....	G 14.
η Virginis	12. 13. 27·55	89. 57. 59·0	....	....	G 19.
Bradley 1731....	12. 48. 13·25	5. 54. 8·0	....	....	G (1873) 4.
Spica	13. 18. 33·37	100. 30. 10·6	....	....	G 105, 10″·6; S 118, 10″·6; E 26, 10″·6.
α² Libræ........	14. 43. 54·62	105. 31. 0·15	....	....	G 39, 60″·4; E 30, 60″·0; S 92, 60″·1.
19 Ursæ Minoris.	....	....	16. 14. 24·50	13. 48. 31·9	G 10, 31″·5; R 4, 32″·8.
ε Ursæ Minoris..	....	....	16. 58. 50·72	7. 45. 37·3	G (1860) 81.
δ Ursæ Minoris..	18. 12. 58·91	3. 23. 34·1	....	....	G 204.
σ Sagittarii	18. 47. 27·08	116. 27. 3·2	....	....	E 4, 2″·91; S 40, 3″·21.
λ Ursæ Minoris .	19. 50. 18·84	1. 4. 17·5	....	....	G 84.
κ¹ Cephei	....	....	20. 13. 3·57	12. 39. 57·5	G 25, (1868–72), 9.
β Aquarii.......	21. 24. 55·43	96. 7. 27·9	....	....	G 27.
δ Capricorni	21. 40. 4·98	106. 41. 51·7	....	....	G 3, 53″·1; S 21, 51″·6; R 8, 51″·65.
α Aquarii.......	21. 59. 18·63	90. 55. 51·9	....	....	G 14.
α Gruis.........	22. 0. 16·90	137. 34. 11·0	....	....	E 30, 11″·0; S 18, 11″·0.
θ Aquarii	22. 10. 10·97	98. 24. 35·7	....	....	G 37.
ζ Aquarii	22. 22. 20·46	90. 39. 50·1	....	....	G 12.
η Aquarii	22. 28. 52·82	90. 45. 58·5	....	....	G 21.
β Gruis.........	22. 35. 8·02	137. 32. 33·3	....	....	E 3, 32″·3; S 7, 33″·7.
Fomalhaut	22. 50. 40·99	120. 17. 21·9	....	....	G 30, 22″·8; R 11, 21″·8; E 53, 21″·7; S 123, 21″·8.
α Pegasi........	....	....	22. 58. 32·08	75. 28. 1·1	G 22.
φ Aquarii.......	23. 7. 47·77	96. 43. 40·2	....	....	G 7, 40″·6; R 6, 39″·7; S 10, 40″·2.
β Sculptoris.....	23. 26. 12·54	128. 30. 52·6	....	....	S 4, 52″·5; E 3, 52″·8.
γ Cephei	23. 34. 11·58	13. 4. 15·2	....	....	G 27.
δ Sculptoris	23. 42. 21·56	118. 49. 36·6	....	....	E 35, 36″·3; S 16, 36″·7; G 9, 37″·5.
ω Piscium	23. 52. 50·47	83. 50. 3·8	....	....	G 23.

TABLE VIII.—OBSERVATIONS of STARS for the COLATITUDE of the ALTAZIMUTH PIER at HONOLULU, and of COLLIMATORS for ZENITH POINT.

TABLE VIII.—OBSERVATIONS of STARS for the COLATITUDE of the ALTAZIMUTH

Day	Observer.	Star.	Time by Altazimuth-Clock.	Lamp Right or Left.	Circle-Reading corrected for Runs of Micrometers.	Level Indication (additive).	Refraction (additive when Lamp L).
1874.			h m s		° ′ ″	″	″
October 2	NI	ω Piscium	23. 54. 48	L	285. 7. 50·4	74·4	15·1
		,, ...	0. 3. 10	R	254. 38. 24·7	66·2	15·3
3	NI	β Aquarii	21. 16. 26	L	297. 30. 15·3	75·0	29·0
		,, ...	21. 28. 28	R	242. 34. 30·1	65·2	28·9
		α Aquarii	21. 55. 3	R	247. 44. 26·9	63·7	22·8
		,, ...	22. 2. 26	L	292. 13. 14·4	71·8	22·8
		ζ Aquarii	22. 26. 45	L	291. 57. 46·8	74·6	22·5
		η Aquarii	22. 33. 48	R	247. 55. 13·4	63·6	22·6
		α Piscis Australis	22. 45. 9	R	218. 24. 29·4	62·6	70·1
		,, ...	22. 53. 7	L	321. 33. 40·0	73·5	70·1
5	T	α Gruis	22. 3. 21	L	338. 49. 40·3	76·4	142·3
		,, ...	22. 10. 5	R	201. 7. 47·8	65·6	142·5
		ζ Aquarii	22. 19. 38	R	248. 2. 8·5	65·4	22·4
		η Aquarii	22. 25. 12	L	292. 3. 54·0	76·2	22·5
		Polaris	22. 33. 19	R	202. 22. 13·3	74·6	133·9
		,, ...	23. 5. 17	L	337. 30. 33·4	66·4	133·2
		α Piscis Australis	22. 44. 57	L	321. 34. 31·1	76·1	69·9
		,, ...	22. 50. 49	R	218. 25. 50·1	64·8	69·9
		γ Cephei	23. 24. 36	L	325. 37. 16·6	67·4	81·0
		,, ...	23. 31. 25	R	214. 22. 48·3	76·0	80·9
6	NI	β Aquarii	21. 19. 12	L	297. 26. 0·3	76·1	28·8
		,, ...	21. 27. 13	R	242. 34. 27·5	67·2	28·8
		α Gruis	21. 53. 48	R	201. 9. 24·6	64·1	142·1
		,, ...	22. 2. 2	L	338. 49. 30·9	71·6	142·1
		θ Aquarii	22. 7. 38	L	299. 41. 38·6	72·8	32·0
		,, ...	22. 15. 10	R	240. 16. 9·6	64·4	32·1
		ζ Aquarii	22. 22. 59	R	248. 2. 25·6	64·0	22·4
		η Aquarii	22. 29. 51	L	292. 3. 4·7	75·4	22·5
		α Piscis Australis	22. 45. 7	L	321. 34. 24·2	76·4	69·8
		,, ...	22. 51. 18	R	218. 25. 50·4	63·7	69·8
10	NI	S. Collimator	—	L	4. 17. 6·1	74·3	—
		,, ...	—	R	175. 42. 24·6	66·3	—
		E. Collimator	—	R	176. 2. 20·7	54·9	—
		,, ...	—	L	3. 57. 10·3	87·6	—

October 6, θ Aquarii, Lamp R. The Circle-Reading has been increased 1′.

PIER at HONOLULU, and of COLLIMATORS for ZENITH POINT.

Barometer and External Thermometer.	Zenith Point for Center Wire, including Zero of Level. Observed.	Adopted.	Concluded Zenith Distance.	Reduction to Meridian.	Tabular Apparent N. P. D. of Star.	Colatitude.
	° ′	° ′				
	270. 0	270. 0				
	″	″	° ′ ″	′ ″	° ′ ″	° ′ ″
30in·18	51·1	51·8	15. 8. 28·1	0. 47·5	83. 49. 43·9	68. 42. 3·3
72°·8		,,	15. 21. 36·2	13. 54·2	,,	42. 1·9
	51·6	,,	27. 31. 7·5	5. 49·7	96. 7. 17·6	41. 59·8
		,,	27. 25. 45·4	0. 27·3	,,	41. 59·5
	51·1	,,	22. 15. 44·0	2. 9·0	90. 55. 38·2	42. 3·2
		,,	22. 13. 57·2	0. 23·6	,,	42. 4·6
	} 52·4 {	,,	21. 58. 32·1	1. 0·5	90. 39. 35·0	42. 3·4
		,,	22. 4. 57·4	1. 18·9	90. 45. 43·1	42. 4·6
30in·24	52·2	,,	51. 36. 29·9	1. 23·5	120. 17. 11·0	42. 4·6
73°·9		,,	51. 35. 11·8	0. 4·7	,,	42. 3·9
	54·9	53·1	68. 52. 25·9	0. 14·9	137. 34. 9·3	41. 58·3
75°·3		,,	68. 54. 22·2	2. 14·8	,,	42. 1·9
	} 54·5 {	,,	21. 58. 1·6	0. 28·0	90. 39. 35·0	42. 1·4
		,,	22. 4. 39·6	0. 55·1	90. 45. 43·1	41. 58·6
	—	55·0	67. 39. 41·0	....	1. 21. 32·4	42. 3·9
	—	,,	67. 32. 58·0	....	,,	42. 4·2
30in·23	51·7	53·1	51. 36. 4·0	0. 59·1	120. 17. 11·3	42. 6·4
75°·5		,,	51. 35. 8·1	0. 0·4	,,	42. 3·6
	54·2	,,	55. 38. 51·9	0. 43·1	13. 3. 55·9	42. 4·7
		,,	55. 38. 9·7	0. 3·0	,,	42. 2·6
	50·2	,,	27. 26. 52·1	1. 43·6	96. 7. 17·7	42. 9·2
		,,	27. 25. 47·2	0. 33·0	,,	42. 3·5
	55·0	,,	68. 52. 46·5	0. 46·0	137. 34. 9·4	42. 8·9
		,,	68. 52. 11·5	0. 7·3	,,	42. 5·2
	53·0	,,	29. 42. 30·3	0. 13·6	98. 24. 23·1	42. 6·4
		,,	29. 44. 11·4	1. 54·5	,,	42. 6·2
	} 48·5 {	,,	21. 57. 45·9	0. 7·7	90. 39. 34·9	41. 56·7
72°·7		,,	22. 3. 49·5	0. 12·4	90. 45. 43·1	42. 6·0
	54·2	,,	51. 35. 57·3	0. 49·3	120. 17. 11·4	42. 3·4
30in·03		,,	51. 35. 8·8	0. 3·1	,,	68. 42. 5·7
—	55·6	56·0	94. 17. 24·4	—	—	—
		,,	94. 17. 25·1	—	—	—
	56·7	,,	93. 57. 40·5	—	—	—
		,,	93. 57. 41·9	—	—	—

Day.		Observer.	Star.	Time by Altazimuth-Clock.	Lamp Right or Left.	Circle-Reading corrected for Runs of Micrometers.	Level Indication (additive).	Refraction (additive when Lamp L).
1874.				h. m. s		° ′ ″	″	″
October	10	T	E. Collimator	—	L	3. 57. 8·1	88·4	—
			,, ...	—	R	176. 2. 21·4	52·7	—
	11	NI	S. Collimator	—	R	175. 40. 26·3	64·8	—
			,, ...	—	L	4. 17. 49·7	73·0	—
			E. Collimator	—	L	3. 57. 28·2	83·6	—
			,, ...	—	R	176. 0. 46·3	55·2	—
	13	NI	S. Collimator	—	R	175. 41. 37·2	63·0	—
			,, ...	—	L	4. 16. 42·1	76·2	—
			E. Collimator	—	L	3. 56. 27·4	85·4	—
			,, ...	—	R	176. 1. 48·0	56·8	—
	16	NI	Polaris...............	23. 6. 55	R	202. 28. 33·9	73·6	132·9
			,, ...	23. 36. 50	L	337. 24. 41·3	66·0	132·4
			,, ...	23. 47. 2	R	202. 35. 3·8	75·2	132·2
			,, ...	0. 3. 16	L	337. 21. 25·0	64·2	132·0
			,, ...	0. 10. 12	R	202. 37. 35·6	76·2	131·9
			,, ...	0. 16. 52	L	337. 20. 1·6	65·5	131·8
	18	NI	S. Collimator	—	L	4. 14. 13·5	72·1	—
			,, ...	—	R	175. 44. 1·4	69·6	—
			E. Collimator	—	L	3. 56. 6·4	78·4	—
			,, ...	—	R	176. 2. 9·6	62·2	—
	22	T	E. Collimator.........	—	R	175. 50. 4·8	69·0	—
			,, ...	—	L	4. 8. 12·6	72·0	—
			,, ...	—		175. 50. 7·0	69·5	—
			,, ...	—	L	4. 8. 12·5	71·4	—
	27	T	α Eridani	1. 30. 41	R	190. 53. 21·2	73·7	279·3
			,, ...	1. 35. 58	L	349. 5. 9·5	65·5	279·4
			Polaris...............	2. 9. 20	L	337. 19. 59·5	76·6	132·2
			,, ...	2. 16. 8	L	337. 20. 42·9	76·6	132·2
			,, ...	2. 24. 15	R	202. 36. 38·7	64·0	132·2
			,, ...	2. 31. 10	R	202. 35. 50·7	63·7	132·3
	30	NI	S Collimator	—	R	175. 41. 56·6	75·8	—
			,, ...	—	L	4. 16. 17·9	62·7	—

October 11. Adjusted wires for horizontality.
October 22. Adjusted the foot-screws. The pier was slowly settling and inclining to the eastward.

Barometer and External Thermometer.	Zenith Point for Center Wire, including Zero of Level. Observed.	Adopted.	Concluded Zenith Distance.	Reduction to Meridian.	Tabular Apparent N. P. D. of Star.	Colatitude.
	° ′	° ′				
	270. 0	270. 0				
	″	″	° ′ ″	′ ″	° ′ ″	° ′ ″
	55·2	56·0	93. 57. 40·5	—	—	—
		,,	93. 57. 41·9	—	—	—
	17·0	16·8	94. 18. 45·6	—	—	—
		,,	94. 18. 46·0	—	—	—
	16·6	,,	93. 58. 35·0	—	—	—
		,,	93. 58. 35·4	—	—	—
	19·2	19·0	94. 17. 38·8	—	—	—
		,,	94. 17. 39·3	—	—	—
	18·8	,,	93. 57. 33·8	—	—	—
		,,	94. 57. 34·2	—	—	—
75°·6		18·5	67. 32. 43·9	....	1. 21. 28·1	68. 42. 7·1
		,,	67. 27. 41·2	....	,,	42. 3·4
		,,	67. 26. 11·7	....	,,	41. 58·6
		,,	67. 24. 22·7	....	,,	42. 5·9
30in·15		,,	67. 23. 38·6	....	,,	42. 3·9
75°·3		,,	67. 23. 0·4	....	,,	42. 2·5
	18·4	18·3	94. 15. 7·3	—	—	—
		,,	94. 15. 7·3	—	—	—
	18·3	,,	93. 57. 6·5	—	—	—
		,,	93. 57. 6·5	—	—	—
	19·2		—	—	—	—
			—	—	—	—
	20·2		—	—	—	—
			—	—	—	—
74°·7	15·5	15·5	79. 10. 19·9	0. 0·8	147. 52. 24·2	42. 5·1
		,,	79. 10. 38·9	0. 18·9	,,	42. 4·2
	15·5	,,	67. 23. 12·8	....	1. 21. 23·6	42. 2·1
		,,	67. 23. 56·2	....	,,	42. 7·3
30in·20		,,	67. 24. 45·0	....	,,	42. 4·7
74°·5		,,	67. 25. 33·4	....	,,	68. 42. 4·9
	16·5		—	—	—	—
			—	—	—	—

Day.		Observer.	Star.	Time by Altazimuth-Clock.	Lamp Right or Left.	Circle-Reading corrected for Runs of Micrometers.	Level Indication (additive).	Refraction (additive when Lamp L).
				h m s		° ′ ″	″	″
1874. November	3	T	β Gruis	22. 38. 23	L	338. 47. 45·1	74·2	141·4
			,, ...	22. 45. 33	R	201. 7. 37·6	66·9	141·8
			α Piscis Australis	22. 51. 44	R	218. 24. 46·8	66·6	69·5
			,, ...	22. 59. 24	L	321. 36. 50·8	73·4	69·7
			β Sculptoris	23. 16. 43	L	329. 47. 43·4	74·8	94·7
			,, ...	23. 24. 39	R	210. 12. 2·1	66·6	94·6
			γ Cephei	23. 33. 3	L	325. 36. 3·0	68·4	80·6
			,, ...	23. 38. 53	R	214. 21. 47·1	71·1	80·6
			β Cassiopeiæ	23. 47. 57	R	232. 45. 43·2	70·4	42·0
			,, ...	23. 53. 9	R	232. 48. 27·9	70·7	41·9
			,, ...	0. 0. 13	L	307. 8. 13·7	678	41·8
			,, ...	0. 7. 0	L	307. 9. 18·3	67·8	41·9
			Bradley 1731 S.P.	0. 17. 40	L	*344. 26. 41·8	69·0	195·8
			,, ...	0. 25. 51	R	195. 27. 6·6	70·4	196·9
			β Phœnicis	1. 6. 15	L	338. 39. 21·8	74·1	140·6
			,, ...	1. 13. 19	R	201. 15. 16·0	66·0	141·0
			α Eridani	1. 21. 38	R	190. 51. 56·0	65·2	279·1
			,, ...	1. 26. 55	L	349. 5. 5·2	73·0	278·5
			,, ...	1. 32. 30	L	349. 4. 48·2	73·8	278·4
			,, ...	1. 37. 43	R	190. 52. 37·6	65·8	278·7
	4	T	E. Collimator	——	L	3. 55. 54·9	74·5	—
			,, ...	——	R	176. 2. 15·6	66·8	—
	6	NI	α Phœnicis	0. 2. 2	R	205. 35. 41·5	64·8	115·1
			,, ...	0. 7. 30	L	334. 18. 21·6	71·6	114·7
			,, ...	0. 16. 34	R	205. 43. 33·2	66·3	114·4
			,, ...	0. 21. 38	L	334. 14. 28·5	71·8	114·4
			ε Cassiopeiæ	1. 16. 55	L	312. 0. 35·9	70·8	49·9
			,, ...	1. 23. 12	R	228. 4. 14·8	70·6	49·7
			α Eridani	1. 29. 15	L	349. 5. 3·5	71·6	279·0
			,, ...	1. 35. 2	R	190. 53. 19·6	69·0	279·0
			127 Eridani	1. 48. 17	R	196. 30. 11·3	66·3	184·4
			,, ...	2. 8. 24	L	343. 33. 38·7	73·2	185·5
			168 Eridani	2. 16. 8	L	339. 31. 18·4	74·0	147·3
			,, ...	2. 21. 58	R	200. 27. 44·4	68·7	147·2
	7	NI	E. Collimator	——	R	175. 58. 50·2	62·8	—
			,, ...	——	L	3. 59. 20·9	75·8	—
	9	NI	α Cassiopeiæ	0. 33. 3	L	304. 31. 44·8	74·2	38·2
			,, ...	0. 40. 5	R	235. 25. 8·1	68·0	38·2

* Bradley 1731 S.P., lamp left, supposed to have been observed on wire B; the circle-reading requires to be increased 3′. 6″·8.

Barometer and External Thermometer.	Zenith Point for Center Wire, including Zero of Level. Observed.	Adopted.	Concluded Zenith Distance.	Reduction to Meridian.	Tabular Apparent N. P. D. of Star.	Colatitude.
	° ′	° ′				
	270. 0	270. 0				
	″	″	° ′ ″	′ ″	° ′ ″	° ′ ″
72°·4	14·7	14·6	68. 51. 6·1	0. 35·3	137. 32. 32·8	68. 42. 2·0
		,,	68. 53. 51·9	3. 21·2	,,	42. 2·1
	13·8	,,	51. 35. 30·7	0. 17·9	120. 17. 15·0	42. 2·2
		,,	51. 38. 59·3	3. 48·0	,,	42. 3·7
	16·1	,,	59. 50. 18·3	1. 35·1	128. 30. 45·5	42. 2·3
29in·97		,,	59. 48. 40·5	0. 0·2	,,	42. 5·2
72°·7	16·0	,,	55. 38. 17·4	0. 0·3	13. 3. 46·5	42. 3·6
		,,	55. 38. 37·0	0. 22·0	,,	42. 1·5
	13·0	,,	37. 14. 3·0	4. 10·8	31. 32. 15·4	42. 7·6
		,,	37. 11. 17·9	1. 26·3	,,	42. 7·0
	12·1	,,	37. 9. 48·7	0. 0·2	31. 32. 15·4	42. 3·9
		,,	37. 10. 53·4	1. 6·2	,,	42. 2·6
	15·6	,,	74. 33. 58·8	2. 38·3	−5. 54. 32·7	42. 0·4
		,,	74. 35. 14·5	1. 20·5	,,	42. 2·3
29in·99	14·3	,,	68. 42. 41·9	1. 18·9	137. 23. 25·6	42. 2·6
72°·2		,,	68. 46. 13·6	4. 50·1	,,	42. 2·1
	15·2	,,	79. 11. 52·5	1. 29·0	147. 52. 26·1	42. 2·6
		,,	79. 10. 42·1	0. 17·4	,,	42. 1·4
	13·2.	,,	79. 10. 25·8	0. 1·9	,,	42. 2·2
		,,	79. 11. 9·9	0. 43·2	,,	41. 59·4
	15·8		—	—	—	—
			—	—	—	—
74°·0	14·5	16·6	64. 25. 25·4	8. 8·7	132. 59. 15·0	41. 58·3
		,,	64. 21. 11·3	3. 58·9	,,	42. 2·6
	18·0	,,	64. 17. 31·5	0. 19·4	,,	42. 3·9
		,,	64. 17. 18·1	0. 3·1	,,	42. 0·0
	18·7	,,	42. 2. 20·0	16. 52·2	26. 56. 41·0	42. 8·8
		,,	41. 55. 40·9	10. 17·0	,,	42. 4·9
	16·0	,,	79. 10. 37·5	0. 15·1	147. 52. 27·0	42. 4·6
		,,	79. 10. 27·0	0. 3·5	,,	42. 3·5
	17·4	,,	73. 32. 3·4	0. 9·9	142. 13. 57·2	42. 3·7
		,,	73. 37. 40·8	5. 45·7	,,	42. 2·1
30in·16	16·2	,,	69. 34. 43·1	0. 52·7	138. 15. 56·1	42. 5·7
74°·3		,,	69. 33. 50·7	0. 0·4	,,	42. 5·8
	14·9		—	—	—	—
			—	—	—	—
73°·6	17·5	16·6	34. 33. 20·6	0. 0·3	34. 8. 45·8	42. 6·1
		,,	34. 34. 38·7	1. 20·1	,,	68. 42. 4·4

Day.	Observer.	Star.	Time by Altazimuth-Clock.	Lamp Right or Left.	Circle-Reading corrected for Runs of Micrometers.	Level Indication (additive).	Refraction (additive when Lamp L).
1874.			h m s		° ′ ″	″	″
November 9	NI	μ Andromedæ.........	0. 49. 48	R	253. 28. 2·6	67·0	16·5
		,, ...	0. 56. 9	L	286. 33. 38·3	70·1	16·5
		Polaris...............	1. 8. 10	L	337. 17. 36·7	72·3	131·8
		,, ...	1. 14. 17	R	202. 40. 35·3	68·4	131·8
10	NI	S. Collimator	——	L	4. 11. 40·4	69·6	—
		,, ...	——	R	175. 46. 30·0	72·7	—
		E. Collimator.........	——	R	176. 8. 13·8	51·8	—
		,, ...	——	L	3. 49. 59·4	88·5	—
		γ Cephei	23. 33. 50	L	325. 36. 0·6	76·2	81·5
		,, ...	23. 41. 28	R	214. 21. 47·9	66·2	81·5
		δ Sculptoris...........	23. 50. 30	L	320. 7. 46·4	66·4	66·8
		,, ...	0. 0. 19	R	219. 41. 36·3	74·2	67·1
		13 Cassiopeiæ.........	0. 19. 38	L	314. 30. 27·5	75·8	54·9
		,, ...	0. 26. 6	R	225. 28. 8·2	66·2	54·9
		β Ceti	0. 35. 47	R	230. 1. 18·2	73·3	46·6
		,, ...	0. 41. 42	L	309. 57. 37·0	69·0	46·5
11	NI	13 Cassiopeiæ.........	0. 17. 36	L	314. 30. 53·5	75·8	54·7
		,, ...	0. 24. 10	R	225. 28. 7·4	67·2	54·7
		α Cassiopeiæ..........	0. 32. 31	R	235. 26. 26·8	65·7	38·3
		,, ...	0. 37. 31	L	304. 32. 14·8	73·8	38·3
		Polaris...............	1. 2. 49	R	202. 40. 34·1	65·2	132·2
		,, ...	1. 7. 5	R	202. 40. 38·5	65·8	132·1
		,, ...	1. 14. 10	L	337. 17. 33·4	75·0	132·1
		,, ...	1. 19. 28	L	337. 17. 33·4	75·0	132·1
		α Eridani.............	1. 28. 57	L	349. 5. 10·2	69·3	279·8
		,, ...	1. 34. 2	R	190. 53. 19·7	74·5	279·6
		46 Cassiopeiæ.........	1. 44. 46	R	223. 13. 44·7	66·4	59·0
		,, ...	1. 50. 32	L	316. 44. 41·5	73·8	59·0
12	NI	α Cassiopeiæ..........	0. 28. 56	R	235. 26. 0·4	61·8	38·6
		,, ...	0. 35. 14	L	304. 31. 47·2	76·4	38·6
		η Cassiopeiæ..........	0. 40. 3	L	305. 49. 44·4	77·4	40·6
		,, ...	0. 46. 13	R	234. 7. 54·4	63·8	40·6
		Polaris...............	1. 0. 50	R	202. 40. 36·3	63·0	133·5
		,, ...	1. 6. 10	L	337. 17. 34·2	77·2	133·5
		,, ...	1. 13. 46	R	202. 40. 41·2	65·0	133·6
		,, ...	1. 19. 13	L	337. 17. 29·6	77·3	133·7
		α Eridani.............	1. 27. 16	R	190. 52. 44·0	76·2	283·6
		,, ...	1. 32. 38	L	349. 4. 52·7	64·4	283·5

Barometer and External Thermometer.	Zenith Point for Center Wire, including Zero of Level. Observed.	Adopted.	Concluded Zenith Distance.	Reduction to Meridian.	Tabular Apparent N. P. D. of Star.	Colatitude.
	° ′	° ′				
	270. 0	270. 0				
	″	″	° ′ ″	′ ″	° ′ ″	° ′ ″
	17·4	16·6	16. 31. 23·5	0. 0·0	52. 10. 37·5	68. 42. 1·0
		,,	16. 34. 48·3	3. 23·2	,,	42. 2·6
30in·15	15·8	,,	67. 20. 44·2	0. 1·2	1. 21. 19·1	42. 2·1
74°·0		,,	67. 20. 44·7	0. 0·0	,,	42. 3·8
	16·4		—	—	—	—
			—	—	—	—
	16 7		—	—	—	—
			—	—	—	—
69°·2	18·5	17·6	55. 38. 20·7	0. 0·1	13. 3. 44·7	42. 5·3
		,,	55. 38. 45·0	0. 26·3	,,	42. 3·4
	18·6	,,	50. 9. 42·0	2. 17·0	118. 49. 26·6	42. 1·6
		,,	50. 18. 34·2	11. 9·1	,,	42. 1·5
	19·3	,,	44. 32. 20·6	0. 22·7	24. 10. 6·9	42. 4·8
		,,	44. 31. 58·1	0. 3·6	,,	42. 1·4
30in·14	15·8	,,	39. 58. 32·7	0. 6·2	108. 40. 27·2	42. 0·7
73°·2		,,	39. 59. 14·9	0. 52·1	,,	42. 4·4
71°·0	18·5	16·6	44. 32. 47·4	0. 46·9	24. 10. 6·6	42. 7·1
		,,	44. 31. 56·7	0. 0·0	,,	42. 3·3
	15·9	,,	34. 33. 22·4	0. 1·4	34. 8. 45·4	42. 6·4
		,,	34. 33. 50·3	0. 30·8	,,	42. 4·9
	15·4	,,	67. 20. 49·5	0. 5·1	1. 21. 18·2	42. 2·6
		,,	67. 20. 44·4	0. 1·8	,,	42. 0·8
	17·2	,,	67. 20. 43·9	0. 0·0	,,	42. 2·1
		,,	67. 20. 43·9	0. 1·8	,,	42. 0·3
	19·0	,,	79. 10. 42·7	0. 16·7	147. 52. 28·3	42. 2·3
		,,	79. 10. 22·0	0. 0·9	,,	42. 7·2
30in·13	15·9	,,	46. 46. 24·5	0. 2·2	21. 55. 40·6	42. 2·9
73°·1		,,	46. 46. 37·7	0. 16·9	,,	42. 1·4
65°·0	17·5	16·6	34. 33. 53·0	0. 35·6	34. 8. 45·2	42. 2·6
		,,	34. 33. 25·6	0. 6·3	,,	42. 4·5
	17·1	,,	35. 51. 25·8	0. 3·5	32. 50. 42·5	42. 4·8
63°·4		,,	35. 51. 59·0	0. 37·8	,,	42. 3·7
	17·8	,,	67. 20. 50·8	0. 7·2	1. 21. 17·9	42. 1·5
		,,	67. 20. 48·3	0. 2·3	,,	42. 3·9
	15·7	,,	67. 20. 44·0	0. 0·0	,,	42. 1·9
		,,	67. 20. 44·0	0. 1·7	,,	42. 0·2
30in·01	15·0	,,	79. 11. 0·0	0. 33·0	147. 52. 28·6	42. 1·6
63°·2		,,	79. 10. 24·0	0. 0·2	,,	68. 42. 4·8

Day.		Observer.	Star.	Time by Altazimuth-Clock.	Lamp Right or Left.	Circle-Reading corrected for Runs of Micrometers.	Level Indication (additive).	Refraction (additive when Lamp L).
				h m s		° ′ ″	″	″
1874. November	13	NI	α Cassiopeiæ	0. 29. 26	R	235. 26. 8·2	64·6	38·7
			,, ...	0. 35. 56	L	304. 31. 53·1	75·3	38·7
			2 Ursæ Minoris	0. 44. 12	L	334. 14. 34·1	77·2	116·0
			,, ...	0. 49. 10	L	334. 14. 24·3	77·4	116·0
			,, ...	0. 55. 25	R	205. 43. 51·6	64·6	116·0
			,, ...	1. 0. 1	R	205. 43. 42·4	64·2	116·0
			Polaris	1. 7. 42	R	202. 40. 40·4	62·9	133·5
			,, ...	1. 12. 18	R	202. 40. 41·8	63·4	133·5
			,, ...	1. 17. 59	L	337. 17. 33·9	76·0	133·4
			,, ...	1. 23. 31	L	337. 17. 37·8	76·3	133·4
			α Eridani	1. 31. 51	R	190. 53. 19·1	74·4	282·5
			,, ...	1. 38. 7	L	349. 5. 17·9	66·2	282·6
	24	NI	S. Collimator	—	R	175. 47. 16·8	80·6	—
			,, ...	—	L	4. 10. 52·2	61·6	—
December	3	NI	S. Collimator	—	R	175. 45. 32·9	79·6	—
			,, ...	—	L	4. 12. 42·7	61·4	—
			,, ...	—	R	175. 45. 33·1	79·9	—
			,, ...	—	L	4. 12. 39·9	62·0	—
	18	NI	S. Collimator	—	L	4. 17. 33·5	56·7	—
			,, ...	—	R	175. 40. 37·0	84·9	—
1875. January	7	NI	ξ Navis	7. 42. 40	L	315. 49. 15·4	52·4	58·4
			,, ...	7. 48. 40	R	224. 8. 5·0	92·5	58·5
			κ[1] Cephei S.P.	7. 59. 14	L	351. 13. 45·6	93·3	353·0
			,, ...	8. 4. 2	L	351. 14. 28·6	94·7	353·6
			,, ...	8. 11. 14	R	188. 43. 27·4	54·7	353·9
			,, ...	8. 15. 40	R	188. 43. 31·0	53·4	353·9
			π Ursæ Majoris	8. 25. 28	R	226. 32. 29·2	53·0	53·9
			,, ...	8. 32. 19	L	313. 26. 1·9	92·6	54·0
			5 Ursæ Majoris	8. 41. 58	L	311. 5. 43·6	94·2	49·8
			,, ...	8. 48. 58	R	228. 51. 44·3	52·8	49·8
	8	NI	52 Eridani	4. 30. 44	L	322. 5. 12·0	70·1	72·5
			,, ...	4. 36. 51	R	217. 51. 37·2	74·4	72·6
			ε Leporis	4. 57. 7	R	226. 9. 31·6	70·4	54·3
			,, ...	5. 3. 50	L	313. 49. 31·3	68·2	54·4
			α Columbæ	5. 28. 25	L	325. 25. 19·5	72·2	82·2
			,, ...	5. 36. 25	R	214. 33. 58·6	74·4	82·2
			β Columbæ	5. 51. 55	R	212. 52. 41·6	70·8	87·6

Barometer and External Thermometer.	Zenith Point for Center Wire, including Zero of Level. Observed.	Adopted.	Concluded Zenith Distance.	Reduction to Meridian.	Tabular Apparent N. P. D. of Star.	Colatitude.
	° ′	° ′				
	270. 0	270. 0				
	″	″	° ′ ″	′ ″	° ′ ″	° ′ ″
	18·5	16·6	34. 33. 42·5	0. 27·8	34. 8. 45·0	68. 41. 59·7
65°·0		,,	34. 33. 30·5	0. 12·1	,,	42. 3·4
	19·2	,,	64. 17. 30·7	0. 9·5	4. 24. 43·4	42. 4·6
		,,	64. 17. 21·1	0. 1·3	,,	42. 4·2
	14·4	,,	64. 17. 16·4	0. 1·8	,,	41. 58·0
		,,	64. 17. 26·0	0. 10·0	,,	41. 59·4
	16·8	,,	67. 20. 46·8	0. 1·4	1. 21. 17·5	42. 2·9
		,,	67. 20. 44·9	0. 0·0	,,	42. 2·4
	17·0	,,	67. 20. 46·7	0. 1·1	,,	42. 3·1
		,,	67. 20. 50·9	0. 5·0	,,	42. 3·4
30in·12	16·1	,,	79. 10. 25·6	0. 1·4	147. 52. 28·8	42. 4·6
67°·2		,,	79. 10. 50·1	0. 26·9	,,	42. 5·6
	15·6	—	—	—	—	—
		—	—	—	—	—
	18·3	—	—	—	—	—
		—	—	—	—	—
	17·4	—	—	—	—	—
		—	—	—	—	—
	16·0	—	—	—	—	—
		—	—	—	—	—
58°·2	26·5	25·6	45. 50. 40·6	0. 0·7	114. 32. 42·7	42. 2·8
		,,	45. 51. 46·6	1. 8·5	,,	42. 4·6
	22·3	,,	81. 20. 46·3	1. 7·4	12. 40. 0·0	41. 53·7
		,,	81. 21. 31·3	0. 26·6	,,	41. 57·9
	25·7	,,	81. 21. 57·4	0. 0·3	,,	41. 57·7
		,,	81. 21. 55·1	0. 5·1	,,	42. 0·2
	25·3	,,	43. 27. 57·3	0. 10·4	25. 14. 16·7	42. 3·6
		,,	43. 28. 2·9	0. 16·6	,,	42. 3·0
30in·03	26·1	,,	41. 7. 42·0	0. 0·1	27. 34. 20·0	42. 1·9
55°·8		,,	41. 8. 38·3	0. 57·4	,,	42. 0·9
63°·5	24·5	24·6	52. 7. 10·0	0. 1·4	120. 49. 11·6	42. 3·0
		,,	52. 8. 45·6	1. 36·7	,,	42. 2·7
	22·4	,,	43. 50. 36·9	0. 12·2	112. 32. 24·6	41. 59·9
		,,	43. 51. 9·3	0. 49·0	,,	42. 4·3
60°·1	24·4	,,	55. 27. 29·3	1. 3·9	124. 8. 29·6	42. 4·2
		,,	55. 26. 33·8	0. 8·1	,,	42. 3·9
	25·9	,,	57. 7. 59·8	1. 7·3	125. 48. 59·5	68. 42. 7·0

Day.		Observer.	Star.	Time by Altazimuth-Clock.	Lamp Right or Left.	Circle-Reading corrected for Runs of Micrometers.	Level Indication (additive).	Refraction (additive when Lamp L).
1875.				h m s		° ′ ″	″	″
January	8	NI	β Columbæ	5. 57. 12	L	327. 8. 35·7	67·8	87·8
			δ Ursæ Minoris S.P. ...	6. 4. 56	R	197. 56. 24·0	69·0	173·4
			,, ...	6. 10. 0	R	197. 56. 22·5	68·3	173·5
			,, ...	6. 17. 1	L	342. 2. 1·9	74·2	173·6
			,, ...	6. 21. 48	L	342. 1. 52·7	74·8	173·6
			Cephei 51	6. 37. 40	L	335. 53. 19·4	75·4	126·5
			,, ...	6. 43. 38	R	204. 5. 2·8	69·6	126·7
	15	T	S. Collimator	——	R	175. 24. 1·5	63·5	—
			,, ...	——	L	4. 34. 9·2	78·5	—
			,, ...	——	R	175. 24. 6·8	63·7	—
			,, ...	——	L	4. 34. 8·2	78·9	—
	28	NI	Polaris..............	5. 46. 45	L	338. 9. 56·4	70·2	138·7
			,, ...	5. 52. 38	L	338. 12. 3·1	70·4	138·9
			,, ...	5. 57. 35	R	201. 44. 40·2	73·0	139·1
			,, ...	6. 2. 18	R	201. 43. 6·9	73·1	139·3
			δ Ursæ Minoris S.P. ...	6. 8. 50	R	197. 56. 6·3	72·2	170·7
			,, ...	6. 15. 43	L	342. 2. 14·1	69·4	170·7
			Canopus.............	6. 21. 28	R	196. 6. 44·6	69·2	190·7
			,, ...	6. 25. 58	L	343. 52. 20·5	73·8	190·9
			Cephei 51	6. 32. 34	R	204. 4. 42·2	73·9	124·3
			,, ...	6. 37. 17	R	204. 4. 49·1	73·5	124·3
			,, ...	6. 44. 53	L	335. 53. 33·7	71·0	124·3
			,, ...	6. 49. 40	L	335. 53. 40·1	72·2	124·3
			λ Ursæ Minoris S.P. ...	7. 36. 23	L	339. 42. 58·6	71·8	150·1
			,, ...	7. 40. 35	L	339. 43. 2·8	72·0	150·1
			,, ...	7. 46. 46	L	339. 43. 5·7	71·9	150·1
			,, ...	7. 53. 8	R	200. 15. 14·0	74·5	150·0
			,, ...	8. 1. 38	R	200. 15. 26·1	74·0	150·0
			,, ...	8. 8. 50	R	200. 15. 33·9	73·2	149·9
	29	NI	Polaris..............	4. 35. 59	R	202. 10. 2·3	70·8	136·6
			,, ...	4. 40. 10	R	202. 8. 50·1	70·2	136·8
			,, ...	4. 45. 1	L	337. 50. 55·6	69·2	137·1
			,, ...	4. 49. 40	L	337. 52. 14·8	70·6	137·3
			ε Ursæ Minoris S.P. ...	4. 56. 35	L	346. 23. 27·8	71·7	227·9
			,, ...	5. 0. 59	L	346. 23. 21·2	71·8	227·9
			,, ...	5. 6. 15	R	193. 35. 11·9	72·2	227·9
			,, ...	5. 10. 56	R	193. 35. 42·3	71·5	227·9
			α Columbæ	5. 24. 38	L	325. 26. 59·4	74·4	81·6

Barometer and External Thermometer.	Zenith Point for Center Wire, including Zero of Level. Observed.	Zenith Point for Center Wire, including Zero of Level. Adopted.	Concluded Zenith Distance.	Reduction to Meridian.	Tabular Apparent N. P. D. of Star.	Colatitude.
	° ′	° ′				
	270. 0	270. 0				
	″	″	° ′ ″	′ ″	° ′ ″	° ′ ″
		24·6	57. 10. 46·7	3. 51·6	125. 48. 59·5	68. 42. 4·4
	24·0	,,	72. 5. 45·0	0. 4·9	3. 23. 46·0	42. 3·9
		,,	72. 5. 47·3	0. 0·2	,,	42. 1·5
	25·1	,,	72. 5. 45·1	0. 3·5	,,	42. 2·6
		,,	72. 5. 36·5	0. 12·1	,,	42. 2·6
30in·11	23·4	,,	65. 56. 16·7	0. 1·0	2. 45. 45·4	42. 1·1
58°·8		,,	65. 56. 18·9	0. 0·7	,,	42. 3·6
	16·3	—	—	—	—	—
		—	—	—	—	—
	18·7	—	—	—	—	—
		—	—	—	—	—
69°·0		23·1	68. 13. 2·2	....	1. 21. 5·1	41. 55·2
	21·1	,,	68. 15. 9·3	....	,,	42. 5·1
		,,	68. 16. 49·0	....	,,	42. 5·2
		,,	68. 18. 22·4	....	,,	42. 2·9
	21·8	,,	72. 5. 55·3	0. 0·7	3. 23. 52·3	42. 3·7
		,,	72. 5. 51·1	0. 2·3	,,	42. 1·1
	25·4	,,	73. 55. 40·0	0. 2·1	142. 37. 43·5	42. 5·6
		,,	73. 56. 22·1	0. 39·6	,,	42. 1·0
	23·4	,,	65. 56. 31·3	0. 6·2	2. 45. 39·1	42. 4·2
		,,	65. 56. 24·8	0. 1·0	,,	42. 2·9
	23·2	,,	65. 56. 25·9	0. 1·8	,,	42. 3·2
69°·0		,,	65. 56. 33·5	0. 7·9	,,	42. 4·7
	22·0	,,	69. 46. 17·4	0. 4·0	1. 4. 19·6	42. 1·8
		,,	69. 46. 21·8	0. 1·4	,,	42. 3·6
	24·2	,,	69. 46. 24·6	0. 0·0	,,	42. 5·0
		,,	69. 46. 24·6	0. 1·5	,,	42. 6·5
30in·15	22·3	,,	69. 46. 13·0	0. 8·0	,,	42. 1·4
69°·7		,,	69. 46. 5·9	0. 17·7	,,	42. 4·0
65°·7		23·1	67. 51. 26·6	....	1. 21. 5·3	42. 1·6
	22·3	,,	67. 52. 39·6	....	,,	42. 4·3
		,,	67. 53. 58·8	....	,,	42. 1·1
		,,	67. 55. 19·6	....	,,	42. 1·6
	24·4	,,	76. 28. 4·3	0. 0·3	7. 46. 1·9	42. 2·7
		,,	76. 27. 57·8	0. 2·8	,,	41. 58·7
	20·6	,,	76. 27. 46·9	0. 18·8	,,	42. 3·8
		,,	76. 27. 17·2	0. 44·8	,,	42. 0·1
	21·7	,,	55. 29. 12·3	2. 42·4	124. 8. 34·5	68. 42. 4·6

Day.		Observer.	Star.	Time by Altazimuth-Clock.	Lamp Right or Left.	Circle-Reading corrected for Runs of Micrometers.	Level Indication (additive).	Refraction (additive when Lamp L).
1875.				h m s		° ′ ″	″	″
January	29	NI	α Columbæ	5. 29. 7	L	325. 25. 3·4	74·3	81·5
			,,	5. 36. 13	R	214. 33. 54·2	71·2	81·5
			,,	5. 41. 11	R	214. 32. 27·8	70·2	81·6
			δ Ursæ Minoris S.P.	5. 53. 51	L	342. 1. 38·4	71·8	171·8
			,,	5. 58. 24	L	342. 1. 54·8	72·0	171·9
			,,	6. 5. 7	R	197. 56. 13·9	73·0	171·9
			,,	6. 9. 33	R	197. 56. 7·7	72·0	171·9
			Canopus	6. 15. 46	L	343. 51. 58·2	72·8	192·3
			,,	6. 20. 35	L	343. 51. 36·5	74·6	192·2
			,,	6. 25. 31	R	196. 6. 9·4	71·4	192·3
			,,	6. 29. 49	R	196. 4. 55·2	70·8	192·5
	30	NI	S. Collimator	—	R	175. 43. 53·9	70·0	—
			,,	—	L	4. 14. 27·6	72·0	—
			,,	—	L	4. 14. 25·8	73·0	—
			,,	—	R	175. 43. 55·5	70·6	—
			Canopus	6. 16. 19	R	196. 6. 28·0	69·7	191·6
			,,	6. 21. 29	R	196. 6. 42·3	69·8	191·5
			,,	6. 27. 49	L	343. 52. 46·8	73·8	191·7
			,,	6. 32. 53	L	343. 54. 41·1	74·7	192·8
	31	T	S. Collimator	—	R	175. 44. 48·0	71·5	—
			,,	—	R	175. 44. 47·8	71·8	—
			,,	—	R	175. 44. 48·5	71·9	—
			,,	—	L	4. 13. 31·9	70·8	—
			,,	—	L	4. 13. 32·6	70·9	—
			Sirius	6. 40. 10	R	232. 9. 3·6	70·6	43·6
			,,	6. 46. 39	L	307. 52. 22·3	70·7	43·7
			ε Canis	6. 53. 7	L	320. 4. 11·1	74·0	67·0
			,,	6. 58. 24	R	219. 52. 58·1	71·5	67·0
			Polaris	7. 5. 26	L	338. 37. 12·5	71·8	142·4
			,,	7. 8. 41	L	338. 38. 19·7	71·9	142·5
			,,	7. 14. 13	R	201. 18. 0·2	72·4	142·7
			,,	7. 18 17	R	201. 16. 33·2	72·0	142·9
February	1	NI	Canopus	6. 16. 21	L	343. 51. 48·6	77·7	192·7
			,,	6. 22. 41	L	343. 51. 43·1	77·8	192·7
			,,	6. 26. 56	R	196. 5. 51·9	68·2	192·8
			,,	6. 31. 51	R	196. 4. 7·6	67·2	193·4
			Polaris	6. 59. 42	L	338. 35. 13·5	68·4	143·2
			,,	7. 5. 14	L	338. 37. 11·7	69·0	143·5

Barometer and External Thermometer.	Zenith Point for Center Wire, including Zero of Level. Observed.	Adopted.	Concluded Zenith Distance.	Reduction to Meridian.	Tabular Apparent N. P. D. of Star.	Colatitude.
	° ′	° ′				
	270. 0	270. 0				
	″	″	° ′ ″	′ ″	° ′ ″	° ′ ″
		23·1	55. 27. 16·1	0. 44·5	124. 8. 34·5	68. 42. 2·9
	23·7	,,	55. 26. 39·2	0. 8·8	,,	42. 4·1
63°·6		,,	55. 28. 6·7	1. 34·0	,,	42. 1·8
	22·0	,,	72. 5. 18·9	0. 34·4	3. 23. 52·6	42. 0·7
		,,	72. 5. 35·6	0. 18·8	,,	42. 1·8
	24·1	,,	72. 5. 48·1	0. 4·3	,,	41. 59·8
		,,	72. 5. 55·3	0. 0·3	,,	42. 3·0
	22·2	,,	73. 56. 0·2	0. 21·7	142. 37. 43·8	42. 5·3
		,,	73. 55. 40·2	0. 0·3	,,	42. 3·9
$30^{\text{in}}\cdot11$	22·7	,,	73. 56. 14·6	0. 34·0	,,	42. 3·2
63°·4		,,	73. 57. 29·6	1. 49·3	,,	42. 3·5
	21·7	—	—	—	—	—
		—	—	—	—	—
	22·4	—	—	—	—	—
		—	—	—	—	—
$30^{\text{in}}\cdot11$	20·9	21·6	73. 55. 55·5	0. 16·4	142. 37. 44·0	42. 4·9
65°·3		,,	73. 55. 41·0	0. 2·2	,,	42. 5·2
	23·0	,,	73. 56. 50·7	1. 9·2	,,	42. 2·5
64°·2		,,	73. 58. 47·0	3. 9·3	,,	42. 6·3
	21·1	—	—	—	—	—
		—	—	—	—	—
	21·9	—	—	—	—	—
		—	—	—	—	—
		—	—	—	—	—
$30^{\text{in}}\cdot15$	23·0	22·6	37. 50. 52·0	0. 7·7	106. 32. 46·6	42. 2·2
65°·6		,,	37. 53. 54·1	3. 9·0	,,	42. 1·5
	22·3	,,	50. 6. 9·5	0. 0·5	118. 48. 12·6	42. 3·6
		,,	50. 7. 20·0	1. 10·4	,,	42. 3·0
		20·6	68. 40. 26·1	....	1. 21. 5·3	42. 4·6
		,,	68. 41. 33·5	....	,,	42. 3·1
$30^{\text{in}}\cdot15$	20·8	,,	68. 43. 30·7	....	,,	42. 2·8
66°·0		,,	68. 44. 58·3	....	,,	42. 4·2
	22·7	24·3	73. 55. 54·7	0. 15·8	142. 37. 44·5	42. 5·6
		,,	73. 55. 49·3	0. 8·0	,,	42. 3·2
	23·8	,,	73. 56. 37·0	0. 54·7	,,	42. 2·2
63°·2		,,	73. 58. 22·9	2. 40·8	,,	42. 2·4
	24·3	,,	68. 38. 20·8	....	1. 21. 5·3	42. 0·5
		,,	68. 40. 19·9	....	,,	68. 42. 2·1

Day.		Observer.	Star.	Time by Altazimuth-Clock.	Lamp Right or Left.	Circle-Reading corrected for Runs of Micrometers.	Level Indication (additive).	Refraction (additive when Lamp L).
1875.				h m s		° ′ ″	″	″
February	1	NI	Polaris	7. 11. 16	R	201. 19. 6·8	74·4	143·8
			,, ...	7. 18. 40	R	201. 16. 31·2	74·0	142·2
			κ¹ Cephei S.P.	7. 58. 40	R	188. 44. 3·2	73·2	351·1
			,, ...	8. 3. 49	R	188. 43. 15·5	73·1	351·6
			,, ...	8. 12. 22	L	351. 15. 37·9	68·3	351·9
			,, ...	8. 18. 53	L	351. 15. 16·2	68·4	351·7
	2	NI	45 Aurigæ............	6. 6. 26	L	302. 11. 56·9	64·2	35·5
			,, ...	6. 13. 14	R	237. 46. 46·0	77·6	35·5
			Sirius................	6. 25. 42	L	307. 56. 47·6	81·4	44·0
			,, ...	6. 30. 22	L	307. 52. 11·0	80·8	43·9
			,, ...	6. 38. 30	R	232. 9. 19·4	64·1	43·8
			,, ...	6. 43. 56	R	232. 7. 55·8	64·0	43·8
			μ Canis	6. 52. 19	R	234. 48. 30·2	63·1	39·8
			,, ...	6. 59. 21	L	305. 14. 36·6	78·8	39·9
	5	T	Polaris	8. 32. 0	L	339. 7. 15·3	67·9	147·5
			,, ...	8. 38. 4	R	200. 49. 8·2	80·1	147·7
			ι Ursæ Majoris	8. 51. 23	R	242. 45. 23·7	80·6	29·2
			,, ...	8. 56. 49	L	297. 15. 5·2	65·9	29·2
			ι Argûs	9. 6. 36	R	190. 0. 55·8	65·2	309·5
			,, ...	9. 10. 36	R	190. 1. 26·4	65·2	309·3
			,, ...	9. 16. 15	L	349. 57. 0·5	79·0	309·4
			,, ...	9. 20. 0	L	349. 57. 44·5	79·8	309·7

Barometer and External Thermometer.	Zenith Point for Center Wire, including Zero of Level. Observed.	Adopted.	Concluded Zenith Distance.	Reduction to Meridian.	Tabular Apparent N. P. D. of Star.	Colatitude.
	° ′	° ′				
	270. 0	270. 0				
	″	″	° ′ ″	′ ″	° ′ ″	° ′ ″
	24·7	24·3	68. 42. 26·9	....	1. 21. 5·3	68. 41. 1·2
30ⁱⁿ·15		,,	68. 45. 3·3	....	,,	42. 0·5
62°·1	26·0	,,	81. 20. 59·0	1. 9·9	12. 40. 8·4	42. 0·5
		,,	81. 21. 47·3	0. 25·8	,,	42. 4·7
	24·7	,,	81. 22. 13·8	0. 0·1	,,	42. 5·5
		,,	81. 21. 52·0	0. 20·4	,,	42. 4·0
64°·0	23·4	22·9	32. 13. 13·7	0. 33·4	36. 29. 23·8	42. 4·1
		,,	32. 12. 54·8	0. 15·5	,,	42. 3·1
	23·2	,,	37. 58. 30·1	7. 47·2	106. 32. 47·0	42. 4·1
		,,	37. 53. 52·8	3. 8·9	,,	42. 3·1
	23·2	,,	37. 50. 43·2	0·0	,,	42. 3·8
63°·3		,,	37. 52. 6·9	1. 24·6	,,	42. 4·7
30ⁱⁿ·13	21·7	,,	35. 11. 29·4	0. 29·2	103. 53. 0·2	42. 0·0
63°·1		,,	35. 16. 12·4	5. 14·6	,,	42. 2·4
59°·1	25·5	25·6	69. 10. 25·1	....	1. 21. 5·7	42. 1·4
		,,	69. 12. 25·0	....	,,	42. 1·6
	21·4	21·6	27. 14. 6·5	0. 9·4	41. 28. 7·1	42. 4·2
		,,	27. 16. 18·7	2. 21·9	,,	42. 3·9
	23·5	,,	80. 3. 30·1	0. 34·5	148. 45. 0·4	42. 4·8
30ⁱⁿ·00		,,	80. 2. 59·3	0. 3·8	,,	42. 4·9
	21·2	,,	80. 3. 7·3	0. 12·9	,,	42. 6·0
58°·0		,,	80. 3. 52·4	0. 52·9	,,	68. 42. 0·9

TABLE IX.—VERTICAL TRANSITS of the MOON and of STARS near the MOON

Day.	Observer.	Object.	Altazimuth-Clock Time of Vertical Transit over Mean of Horizontal Wires.	Lamp Right or Left.	Reading of Vertical Circle corrected for Runs of Micrometers.	Level Indication (additive).	Barometer and External Thermometer.	Refraction.	True observed Zenith Distance.
1874.			h m s		° ′ ″	″		″	° ′ ″
October 3	T	Moon's L. L. ...	5. 15. 3·38	R	222. 0. 28·9	66·0	30in·22	62·0	48. 0. 22·7
		,, ...	5. 25. 17·52	L	315. 43. 32·6	76·2	71°·5	57·3	45. 44. 50·5
		,, ...	5. 34. 17·60	L	313. 44. 8·7	75·4		53·5	43. 45. 22·0
		,, ...	5. 42. 24·96	L	311. 56. 12·6	74·6		50·2	41. 57. 21·8
		,, ...	5. 50. 1·96	R	229. 44. 50·9	62·4		47·3	40. 15. 49·6
		,, ...	5. 57. 22·04	R	231. 22. 40·1	62·6		44·7	38. 37. 57·6
		γ Leonis	6. 6. 15·00	R	212. 37. 3·6	62·1		87·2	57. 24. 17·1
		,, ...	6. 16. 22·80	L	325. 3. 37·1	75·4	71°·0	79·9	55. 5. 16·8
4	NI	Moon's L. L. ...	5. 30. 53·60	L	326. 50. 48·3	75·0		85·3	56. 52. 31·7
		,, ...	5. 41. 33·30	L	324. 28. 15·4	75·4		78·0	54. 29. 51·9
		,, ...	5. 52. 9·68	R	217. 53. 37·5	66·0		71·6	52. 7. 25·0
		,, ...	6. 2. 33·20	R	220. 13. 22·6	65·8	72°·7	65·9	49. 47. 34·4
		,, ...	6. 39. 6·88	L	311. 32. 14·4	73·9	30in·23	49·4	41. 33. 20·8
		,, ...	6. 46. 59·94	R	230. 14. 19·9	66·5	73°·0	46·4	39. 46. 16·9
5	NI	Regulus	4. 50. 17·82	R	195. 52. 29·9	59·6		193·2	74. 10. 40·6
		,, ...	5. 4. 56·80	L	340. 44. 19·0	81·5	72°·0	158·1	70. 47. 21·7
		Moon's L. L. ...	5. 18. 10·52	L	341. 48. 23·2	81·2		167·9	71. 51. 35·4
		,, ...	5. 26. 12·98	L	340. 1. 4·9	82·1		152·1	70. 4. 2·2
		,, ...	5. 34. 22·66	L	338. 11. 50·9	81·2		138·6	68. 14. 33·8

	° ′ ″
October 3. The adopted Zenith point corresponding to the mean wire is	270. 0. 55·6
October 4. ,, ,, ,,	270. 0. 56·9
October 5. ,, ,, ,,	270. 0. 56·9

observed with the ALTAZIMUTH, and Inferred LONGITUDE of HONOLULU.

Greenwich Mean Solar Time, assuming the West Longitude to be I. 10h. 31m. 0s. II. 10h. 32m. 0s.	Tabular Geocentric Elements (R. A. and N. P. D. corrected).				Hour-Angle.	Tabular Zenith Distance of Star or of Limb of Moon.	Inferred Longitude West of Greenwich 10h. 31m. +
	Apparent Right Ascension of Center.	Apparent North Polar Distance of Center.	Equatorial Horizontal Parallax.	Semi-diameter.			
h m s	h m s	° ′ ″	′ ″	′ ″	° ′ ″	° ′ ″	s
I. 2. 52. 52·58	8. 38. 59·85	66. 10. 1·5	56. 5·2	15. 18·5	51. 9. 20·55	48. 0. 13·8	
II. 2. 53. 52·41	8. 39. 2·07	66. 10. 10·0	56. 5·2	15. 18·5	51. 9. 53·85	48. 0. 45·1	17·1
I. 3. 3. 5·30	8. 39. 22·57	66. 11. 29·0	56. 4·9	15. 18·4	48. 41. 25·50	45. 44. 38·9	
II. 3. 4. 5·14	8. 39. 24·79	66. 11. 37·5	56. 4·9	15. 18·4	48. 41. 58·80	45. 45. 10·4	22·1
I. 3. 12. 4·12	8. 39. 42·54	66. 12. 46·0	56. 4·6	15. 18·4	46. 31. 20·25	43. 45. 9·4	
II. 3. 13. 3·96	8. 39. 44·76	66. 12. 54·6	56. 4·6	15. 18·4	46. 31. 53·55	43. 45. 40·6	24·2
I. 3. 20. 10·35	8. 40. 0·56	66. 13. 55·7	56. 4·6	15. 18·3	44. 33. 57·45	41. 57. 8·8	
II. 3. 21. 10·19	8. 40. 2·76	66. 14. 4·2	56. 4·6	15. 18·3	44. 34. 30·45	41. 57. 39·8	25·2
I. 3. 27. 46·30	8. 40. 17·44	66. 15. 1·1	56. 4·2	15. 18·2	42. 43. 52·65	40. 15. 41·7	
II. 3. 28. 46·14	8. 40. 19·65	66. 15. 9·7	56. 4·2	15. 18·2	42. 44. 25·80	40. 16. 12·7	15·3
I. 3. 35. 5·35	8. 40. 33·69	66. 16. 4·3	56. 4·0	15. 18·2	40. 57. 52·65	38. 37. 52·2	
II. 3. 36. 5·18	8. 40. 35·90	66. 16. 12·8	56. 4·0	15. 18·2	40. 58. 25·80	38. 38. 23·4	10·4
——	10. 13. 2·50	69. 31. 22·9	—	—	61. 51. 46·95	57. 24. 22·5	—
——	,,	,,	—	—	59. 19. 46·20	55. 5. 21·3	—
I. 3. 5. 21·22	9. 30. 53·30	70. 6. 49·3	55. 29·2	15. 8·7	60. 0. 53·70	56. 52. 19·4	
II. 3. 6. 21·05	9. 30. 55·35	70. 7. 0·2	55. 29·2	15. 8·7	60. 1. 24·45	56. 52. 50·1	24·0
I. 3. 15. 59·41	9. 31. 15·25	70. 8. 45·3	55. 29·1	15. 8·7	57. 26. 23·85	54. 29. 37·0	
II. 3. 16. 59·25	9. 31. 17·31	70. 8. 56·1	55. 29·1	15. 8·7	57. 26. 54·75	54. 30. 7·8	29·0
I. 3. 26. 34·32	9. 31. 37·07	70. 10. 40·7	55. 28·8	15. 8·6	54. 52. 41·40	52. 7. 15·5	
II. 3. 27. 34·16	9. 31. 39·13	70. 10. 51·6	55. 28·8	15. 8·6	54. 53. 12·30	52. 7. 46·2	18·6
I. 3. 36. 56·38	9. 31. 58·45	70. 12. 33·8	55. 28·6	15. 8·6	52. 22. 5·70	49. 47. 26·5	
II. 3. 37. 56·22	9. 32. 0·51	70. 12. 44·8	55. 28·6	15. 8·6	52. 22. 36·60	49. 47. 57·1	15·5
I. 4. 13. 24·95	9. 33. 13·56	70. 19. 13·4	55. 27·7	15. 8·3	43. 32. 13·80	41. 33. 7·2	
II. 4. 14. 24·79	9. 33. 15·61	70. 19. 24·4	55. 27·7	15. 8·3	43. 32. 44·55	41. 33. 37·7	26·7
I. 4. 21. 16·92	9. 33. 29·74	70. 20. 39·9	55. 27·5	15. 8·2	41. 37. 57·75	39. 46. 5·6	
II. 4. 22. 16·75	9. 33. 31·80	70. 20. 50·8	55. 27·5	15. 8·2	41. 38. 28·65	39. 46. 35·9	23·1
——	10. 1. 40·67	77. 25. 5·5	—	—	77. 42. 48·45	74. 10. 45·1	—
——	,,	,,	—	—	74. 2. 58·05	70. 47. 27·8	—
I. 2. 49. 20·41	10. 18. 14·08	74. 45. 31·5	55. 0·0	15. 0·7	74. 52. 48·60	71. 51. 15·9	
II. 2. 50. 20·25	10. 18. 16·00	74. 45. 43·9	55. 0·0	15. 0·7	74. 53. 17·40	71. 51. 46·1	38·7
I. 2. 57. 21·76	10. 18. 29·56	74. 47. 11·7	54. 59·8	15. 0·7	72. 56. 0·90	70. 3. 44·4	
II. 2. 58. 21·60	10. 18. 31·49	74. 47. 24·2	54. 59·8	15. 0·7	72. 56. 29·85	70. 4. 14·8	35·1
I. 3. 5. 30·30	10. 18. 45·27	74. 48. 53·5	54. 59·8	15. 0·6	70. 57. 28·35	68. 14. 21·6	
II. 3. 6. 30·14	10. 18. 47·20	74. 49. 6·0	54. 59·8	15. 0·6	70. 57. 57·30	68. 14. 51·9	24·2

Day.	Observer.	Object.	Altazimuth-Clock Time of Vertical Transit over Mean of Horizontal Wires.	Lamp Right or Left.	Reading of Vertical Circle corrected for Runs of Micrometers.	Level Indication (additive).	Barometer and External Thermometer.	Refraction.	True observed Zenith Distance.
1874.			h m s		° ′ ″	″		″	° ′ ″
October 5	NI	Moon's L. L. ...	5. 47. 17·02	R	204. 40. 49·6	64·0		120·9	65. 21. 4·2
		,, ...	5. 56. 44·18	R	206. 47. 58·7	62·2	30in·16	110·1	63. 13. 46·1
		,, ...	6. 5. 30·22	R	208. 46. 15·0	61·4	71°·2	101·3	61. 15. 21·8
7	T	Regulus........	6. 7. 58·84	R	214. 5. 39·4	56·8		82·9	55. 55. 45·1
		,, ...	6. 17. 34·34	L	323. 39. 55·4	86·0	67°·6	76·3	53. 41. 39·3
		Moon's L. L. ...	6. 27. 13·16	L	350. 5. 32·3	86·5		310·4	80. 11. 10·8
		,, ...	6. 33. 32·60	R	191. 18. 57·9	55·5		273·0	78. 45. 38·0
		,, ...	6. 38. 39·04	R	192. 27. 40·2	55·6		248·4	77. 36. 31·0
		,, ...	6. 44. 3·12	L	346. 19. 11·4	87·4		226·6	76. 23. 27·0
		,, ...	6. 50. 43·02	L	344. 49. 24·8	87·2	30in·14	204·1	74. 53. 17·7
		,, ...	6. 56. 28·96	R	196. 28. 0·7	54·8	67°·6	187·6	73. 35. 10·5
15	T	Moon's L. L. ...	21. 51. 11·30	L	348. 42. 59·6	61·0	74°·6	270·2	78. 48. 8·5
		,, ...	21. 58. 14·50	R	189. 59. 23·0	79·1	30in·15	303·0	80. 4. 43·2
		,, ...	22. 6. 54·74	R	188. 25. 6·2	78·0		355·7	81. 39. 53·8
		,, ...	22. 16. 8·32	L	353. 14. 24·9	59·4		435·0	83. 22. 17·0
		σ Sagittarii	22. 28. 47·52	L	341. 48. 55·7	62·2	75°·0	167·3	71. 52. 22·9
		,, ...	22. 36. 42·26	R	196. 43. 14·4	77·8		182·1	73. 18. 52·2
17	NI	Moon's L. L. ...	23. 45. 25·28	R	192. 22. 42·4	72·4		246·6	77. 40. 34·1
		,, ...	0. 7. 41·64	L	351. 38. 41·9	65·7	30in·15	359·7	81. 45. 25·0
		,, ...	0. 15. 23·82	R	186. 54. 34·3	72·4	74°·0	425·5	83. 11. 41·1

		° ′ ″
October 7.	The adopted Zenith point corresponding to the mean wire is	270. 0. 58·4.
October 15.	,, ,, ,,	270. 0. 22·3.
October 17.	,, ,, ,,	270. 0. 22·3.

Greenwich Mean Solar Time, assuming the West Longitude to be I. 10h. 31m. 0s. II. 10h. 32m. 0s.	Tabular Geocentric Elements (R. A. and N. P. D. corrected). Apparent Right Ascension of Center.	Apparent North Polar Distance of Center.	Equatorial Horizontal Parallax.	Semi-diameter.	Hour-Angle.	Tabular Zenith Distance of Star or of Limb of Moon.	Inferred Longitude West of Greenwich 10h. 31m. +
h m s	h m s	° ′ ″	′ ″	′ ″	° ′ ″	° ′ ″	s
I. 3. 13. 22·87	10. 19. 10·11	74. 51. 34·7	54. 59·6	15. 0·6	67. 50. 30·60	65. 20. 55·0	
II. 3. 19. 22·71	10. 19. 12·03	74. 51. 47·2	54. 59·6	15. 0·6	67. 50. 29·40	65. 21. 25·2	18·3
I. 3. 27. 48·73	10. 19. 28·29	74. 53. 32·8	54. 59·4	15. 0·5	65. 32. 42·15	63. 13. 32·3	
II. 3. 28. 48·57	10. 19. 30·22	74. 53. 45·3	54. 59·4	15. 0·5	65. 33. 11·10	63. 14. 2·7	27·2
I. 3. 36. 33·54	10. 19. 45·15	74. 55. 22·4	54. 59·2	15. 0·5	63. 25. 21·45	61. 15. 10·2	
II. 3. 37. 33·37	10. 19. 47·07	74. 55. 34·9	54. 59·2	15. 0·5	63. 25. 20·25	61. 15. 40·4	23·0
——	10. 1. 40·73	77. 25. 5·7	—	—	58. 3. 27·00	55. 55. 44·7	—
——	,,	,,	—	—	55. 39. 30·75	53. 41. 39·0	—
I. 3. 51. 16·02	11. 48. 14·84	85. 44. 58·9	54. 18·2	14. 49·3	79. 53. 16·65	80. 10. 57·2	
II. 3. 52. 15·86	11. 48. 16·60	85. 45. 12·9	54. 18·2	14. 49·3	79. 53. 43·05	80. 11. 26·9	27·5
I. 3. 57. 34·60	11. 48. 26·00	85. 46. 27·6	54. 18·1	14. 49·3	78. 21. 9·90	78. 45. 24·7	
II. 3. 58. 34·43	11. 48. 27·76	85. 46. 41·6	54. 18·1	14. 49·3	78. 21. 36·30	78. 45. 54·4	26·9
I. 4. 2. 40·32	11. 48. 35·00	85. 47. 39·1	54. 18·0	14. 49·3	77. 6. 46·50	77. 36. 18·4	
II. 4. 3. 40·15	11. 48. 36·77	85. 47. 53·1	54. 18·0	14. 49·3	77. 7. 13·05	77. 36. 48·1	25·4
I. 4. 8. 3·64	11. 48. 44·53	85. 48. 54·8	54. 18·0	14. 49·2	75. 48. 6·30	76. 23. 12·6	
II. 4. 9. 3·48	11. 48. 46·29	85. 49. 8·8	54. 18·0	14. 49·2	75. 48. 32·70	76. 23. 42·2	29·2
I. 4. 14. 42·61	11. 48. 56·29	85. 50. 28·3	54. 17·9	14. 49·2	74. 11. 1·65	74. 53. 0·0	
II. 4. 15. 42·45	11. 48. 58·05	85. 50. 42·3	54. 17·9	14. 49·2	74. 11. 28·05	74. 53. 29·5	36·0
I. 4. 20. 27·74	11. 49. 6·45	85. 51. 49·1	54. 17·8	14. 49·2	72. 47. 3·00	73. 34. 57·5	
II. 4. 21. 27·58	11. 49. 8·22	85. 52. 3·1	54. 17·8	14. 49·2	72. 47. 28·20	73. 35. 26·0	27·4
I. 18. 44. 15·50	17. 43. 4·04	117. 58. 28·6	55. 7·5	15. 2·8	62. 9. 56·10	78. 48. 20·7	
II. 18. 45. 15·33	17. 43. 6·33	117. 58. 30·9	55. 7·5	15. 2·8	62. 9. 21·75	78. 47. 56·3	31·9
I. 18. 51. 17·55	17. 43. 20·24	117. 58. 44·9	55. 7·7	15. 2·8	63. 51. 41·25	80. 4. 54·6	
II. 18. 52. 17·39	17. 43. 22·54	117. 58. 47·2	55. 7·7	15. 2·8	63. 51. 6·75	80. 4. 29·8	27·6
I. 18. 59. 56·38	17. 43. 40·18	117. 59. 4·9	55. 7·9	15. 2·9	65. 56. 46·05	81. 40. 2·9	
II. 19. 0. 56·22	17. 43. 42·48	117. 59. 7·2	55. 7·9	15. 2·9	65. 56. 11·55	81. 39. 37·8	21·7
I. 19. 9. 8·49	17. 44. 1·40	117. 59. 25·9	55. 8·1	15. 2·9	68. 9. 51·90	83. 22. 26·2	
II. 19. 10. 8·33	17. 44. 3·70	117. 59. 28·2	55. 8·1	15. 2·9	68. 9. 17·40	83. 22. 0·7	21·6
——	18. 47. 29·15	116. 27. 10·5	—	—	55. 27. 44·10	71. 52. 25·6	—
——	,,	,,	—	—	57. 26. 25·50	73. 18. 53·8	..
I. 20. 30. 28·27	19. 40. 17·60	116. 49. 5·9	56. 32·7	15. 26·0	61. 27. 22·65	77. 40. 41·5	
II. 20. 31. 28·10	19. 40. 19·66	116. 49. 0·7	56. 32·7	15. 26·0	61. 26. 47·25	77. 40. 12·1	15·1
I. 20. 52. 41·06	19. 41. 10·23	116. 47. 9·2	56. 33·5	15. 26·2	66. 48. 19·95	81. 45. 26·5	
II. 20. 53. 40·90	19. 41. 12·60	116. 47. 3·9	56. 33·5	15. 26·2	66. 47. 44·40	81. 44. 56·3	3·0
I. 21. 0. 22·01	19. 41. 28·44	116. 46. 28·6	56. 33·7	15. 26·3	68. 39. 19·95	83. 11. 44·3	
II. 21. 1. 21·85	19. 41. 30·80	116. 46. 23·3	56. 33·7	15. 26·3	68. 38. 44·55	83. 11. 14·0	6·3

Day.	Observer.	Object.	Altazimuth-Clock Time of Vertical Transit over Mean of Horizontal Wires.	Lamp Right or Left.	Reading of Vertical Circle corrected for Runs of Micrometers.	Level Indication (additive).	Barometer and External Thermometer.	Refraction.	True observed Zenith Distance.
1874.			h m s		° ′ ″	″		″	° ′ ″
October 18	T	Moon's L. L. ...	0. 50. 17·50	R	192. 45. 36·5	77·6		240·2	77. 17. 28·4
		,, ...	0. 58. 33·98	R	191. 12. 40·8	75·3		272·6	78. 50. 58·8
		,, ...	1. 4. 13·54	L	349. 49. 47·9	63·6		300·2	79. 55. 29·4
		,, ...	1. 13. 18·62	L	351. 33. 19·2	64·4		357·5	81. 39. 58·8
		,, ...	1. 19. 5·28	L	352. 39. 29·2	64·8		406·1	82. 46. 57·8
		,, ...	1. 25. 5·34	R	186. 10. 0·4	76·0		471·6	83. 56. 57·5
		* Gruis	1. 33. 7·76	R	190. 53. 35·2	72·5	30in·19	280·3	79. 10. 14·9
		β Gruis	1. 41. 17·16	L	350. 30. 15·7	66·8	72°·8	320·4	80. 36. 20·6
19	NI	Moon's L. L. ...	0. 0. 18·22	L	325. 54. 40·8	64·0		81·9	55. 56. 44·4
		. ...	0. 9. 25·56	R	212. 37. 34·6	75·3		86·4	57. 22. 58·8
		,, ...	0. 17. 39·56	L	328. 40. 56·5	62·8		91·0	58. 43. 8·0
		,, ...	0. 25. 26·08	R	210. 0. 2·8	76·8		95·7	60. 0. 38·4
		,, ...	0. 34. 52·34	L	331. 34. 38·6	63·6		102·2	61. 37. 2·1
		,, ...	0. 43. 4·32	R	206. 58. 19·3	76·4		108·5	63. 2. 35·1
		Fomalhaut......	0. 53. 59·84	R	210. 25. 21·1	73·6	30in·19	94·1	59. 35. 21·8
		,, ...	1. 4. 12·16	L	330. 48. 53·9	65·3	75°·0	99·1	60. 51. 15·9
21	NI	Moon's L. L. ...	1. 34. 21·92	L	314. 47. 38·0	61·2	73°·1	55·4	44. 49. 12·3
		,, ...	1. 43. 17·60	L	316. 23. 27·7	61·2	30in·17	58·6	46. 25. 5·2
		,, ...	1. 54. 25·98	L	318. 15. 20·6	61·2		62·6	48. 17. 2·1
		,, ...	2. 2. 5·60	L	319. 41. 40·7	61·1		65·8	49. 43. 25·3

October 18. The adopted Zenith point corresponding to the mean wire is 270. 0. 22·3.
October 19. ,, ,, ,, 270. 0. 22·3.
October 21. ,, ,, ,, 270. 0. 22·3.

Greenwich Mean Solar Time, assuming the West Longitude to be I. 10ʰ. 31ᵐ. 0ˢ. II. 10ʰ. 32ᵐ. 0ˢ.	Tabular Geocentric Elements (R. A. and N. P. D. corrected). Apparent Right Ascension of Center.	Apparent North Polar Distance of Center.	Equatorial Horizontal Parallax.	Semi-diameter.	Hour-Angle.	Tabular Zenith Distance of Star or of Limb of Moon.	Inferred Longitude West of Greenwich 10ʰ. 31ᵐ. +
h m s	h m s	° ′ ″	′ ″	′ ″	° ′ ″	° ′ ″	s
I. 21. 31. 19·94	20. 39. 9·07	113. 51. 0·6	57. 27·0	15. 40·9	62. 58. 56·55	77. 17. 42·4	
II. 21. 32. 19·27	20. 39. 11·40	113. 50. 51·6	57. 27·0	15. 40·9	62. 58. 21·60	77. 17. 10·4	26·2
I. 21. 39. 34·59	20. 39. 28·29	113. 49. 46·4	57. 27·4	15. 40·9	64. 58. 15·75	78. 51. 13·8	
II. 21. 40. 34·42	20. 39. 30·62	113. 49. 37·5	57. 27·4	15. 40·9	64. 57. 40·80	78. 50. 41·7	28·0
I. 21. 45. 13·24	20. 39. 41·45	113. 48. 55·7	57. 27·6	15. 41·0	66. 19. 52·05	79. 55. 45·1	
II. 21. 46. 13·08	20. 39. 43·77	113. 48. 46·7	57. 27·6	15. 41·0	66. 19. 17·25	79. 55. 12·9	29·3
I. 21. 54. 16·87	20. 40. 2·55	113. 47. 34·0	57. 27·9	15. 41·1	68. 30. 52·35	81. 40. 13·0	
II. 21. 55. 16·70	20. 40. 4·87	113. 47. 25·0	57. 27·9	15. 41·1	68. 30. 17·55	81. 39. 40·7	26·4
I. 22. 0. 2·59	20. 40. 15·97	113. 46. 41·9	57. 28·1	15. 41·2	69. 54. 11·10	82. 47. 11·5	
II. 22. 1. 2·42	20. 40. 18·29	113. 46. 32·9	57. 28·1	15. 41·2	69. 53. 36·30	82. 46. 39·1	25·4
I. 22. 6. 1·69	20. 40. 29·91	113. 45. 47·8	57. 28·4	15. 41·2	71. 20. 43·20	83. 57. 10·8	
II. 22. 7. 1·52	20. 40. 32·23	113. 45. 38·7	57. 28·4	15. 41·2	71. 20. 8·40	83. 56. 38·4	24·6
——	——	——	—	—	——	——	—
——	22. 35. 12·13	137. 32. 30·2	—	—	46. 43. 8·10	80. 36. 25·2	—
I. 20. 37. 36·92	21. 32. 20·51	109. 46. 55·6	58. 21·3	15. 55·6	37. 12. 23·10	55. 56. 49·0	
II. 20. 38. 36·75	21. 32. 22·78	109. 46. 43·6	58. 21·3	15. 55·6	37. 11. 49·05	55. 56. 18·2	9·0
I. 20. 46. 42·79	21. 32. 41·20	109. 45. 5·5	58. 21·6	15. 55·7	39. 24. 3·30	57. 23. 3·1	
II. 20. 47. 42·63	21. 32. 43·46	104. 44. 53·5	58. 21·6	15. 55·7	39. 23. 29·40	57. 22. 32·1	8·3
I. 20. 54. 55·47	21. 32. 59·86	109. 43. 26·1	58. 22·0	15. 55·8	41. 22. 53·85	58. 43. 11·5	
II. 20. 55. 55·31	21. 33. 2·12	109. 43. 14·0	58. 22·0	15. 55·8	41. 22. 19·95	58. 42. 40·0	6·7
I. 21. 2. 40·75	21. 33. 17·48	109. 41. 52·0	58. 22·3	15. 55·9	43. 15. 7·80	60. 0. 44·0	
II. 21. 3. 40·59	21. 33. 19·74	109. 41. 39·9	58. 22·3	15. 55·9	43. 14. 33·90	60. 0. 12·2	10·6
I. 21. 12. 5·50	21. 33. 38·87	109. 39. 57·6	58. 22·6	15. 56·0	45. 31. 21·30	61. 37. 6·5	
II. 21. 13. 5·33	21. 33. 41·13	109. 39. 45·5	58. 22·6	15. 56·0	45. 30. 47·40	61. 36. 34·2	8·2
I. 21. 20. 16·17	21. 33. 57·44	109. 38. 18·2	58. 23·0	15. 56·1	47. 29. 42·90	63. 2. 42·5	
II. 21. 21. 16·00	21. 33. 59·70	109. 38. 6·0	58. 23·0	15. 56·1	47. 29. 9·00	63. 2. 10·0	13·7
——	22. 50. 44·46	120. 17. 13·1	—	—	31. 1. 51·00	59. 35. 19·9	—
——	,,	,,	—	—	33. 34. 56·25	60. 51. 10·0	—
I. 22. 4. 43·41	23. 22. 14·48	97. 39. 22·5	60. 13·5	16. 26·3	33. 32. 22·05	44. 49. 18·4	
II. 22. 5. 43·25	23. 22. 16·66	97. 39. 5·7	60. 13·5	16. 26·3	33. 31. 49·35	44. 48. 43·1	10·4
I. 22. 13. 37·67	23. 22. 33·98	97. 36. 52·7	60. 13·8	16. 26·3	35. 41. 25·35	46. 25. 12·5	
II. 22. 14. 37·51	23. 22. 36·16	97. 36. 35·9	60. 13·8	16. 26·3	35. 40. 52·65	46. 24. 36·9	12·3
I. 22. 23. 44·44	23. 22. 56·13	97. 34. 2·5	60. 14·2	16. 26·4	38. 7. 59·55	48. 17. 7·0	
II. 22. 24. 44·28	23. 22. 58·31	97. 33. 45·7	60. 14·2	16. 26·4	38. 7. 26·85	48. 16. 31·1	8·2
I. 22. 31. 22·85	23. 23. 12·85	97. 31. 53·7	60. 14·4	16. 26·5	39. 58. 43·65	49. 43. 33·0	
II. 22. 32. 22·69	23. 23. 15·04	97. 31. 37·0	60. 14·4	16. 26·5	39. 58. 10·80	49. 42. 56·8	2·8

Day.	Observer.	Object.	Altazimuth-Clock Time of Vertical Transit over Mean of Horizontal Wires.	Lamp Right or Left.	Reading of Vertical Circle corrected for Runs of Micrometers.	Level Indication (additive).	Barometer and External Thermometer.	Refraction.	True observed Zenith Distance.
1874.			h m s		° ′ ″	″		″	° ′ ″
October 21	NI	Moon's L. L. ...	2. 11. 49·02	L	321. 33. 22·0	61·2		70·3	51. 35. 11·2
		,, ...	2. 20. 49·52	R	216. 39. 42·0	80·5		74·9	53. 20. 34·7
		,, ...	2. 29. 47·84	R	214. 53. 8·4	80·6		79·9	55. 7. 13·2
		,, ...	2. 47. 30·26	R	211. 18. 50·5	80·6		91·4	58. 41. 42·6
22	NI	Moon's L. L. ...	3. 36. 53·94	L	324. 3. 49·1	71·4	73°·0	76·7	54. 5. 54·9
		,, ...	3. 51. 22·92	L	327. 10. 41·6	71·8	30in·16	86·1	57. 12 57·2
		,, ...	4. 1. 58·64	L	329. 28. 29·0	72·9		94·1	59. 30. 53·7
		,, ...	4. 28. 19·68	R	204. 44. 3·7	69·7		119·9	65. 17. 8·8
		,, ...	4. 46. 51·96	R	200. 39. 0·8	69·1		146·0	69. 22. 38·4
		,, ...	5. 8. 52·80	R	195. 46. 58·9	68·8	75°·1	193·3	74. 15. 27·9
23	T	Moon's L. L. ...	3. 11. 33·78	L	303. 24. 15·9	69·6	74°·0	36·6	33. 25. 40·8
		,, ...	3. 21. 32·96	L	305. 30. 15·3	70·2		39·6	35. 31. 43·8
		,, ...	3. 27. 59·68	L	306. 52. 30·3	70·3		41·7	36. 54. 1·0
		,, ...	3. 34. 17·80	L	308. 13. 27·8	70·2		43·8	38. 15. 0·5
		,, ...	3. 41. 32·62	R	230. 11. 12·3	72·7		46·3	39. 48. 42·6
		,, ...	3. 48. 25·20	R	228. 41. 43·2	71·8		48·8	41. 18. 15·1
		,, ...	3. 54. 34·16	R	227. 21. 20·8	71·3		51·2	42. 38. 40·4
		,, ...	4. 0. 41·12	R	226. 1. 3·0	70·9		53·6	43. 59. 1·0

October 22. The adopted Zenith point corresponding to the mean wire is 270. 0. 22·3.
October 23. ,, ,, ,, 270. 0. 21·3.

Greenwich Mean Solar Time, assuming the West Longitude to be I. 10ʰ. 31ᵐ. 0ˢ. II. 10ʰ. 32ᵐ. 0ˢ.	Tabular Geocentric Elements (R. A. and N. P. D. corrected). Apparent Right Ascension of Center.	Apparent North Polar Distance of Center.	Equatorial Horizontal Parallax.	Semi-diameter.	Hour-Angle.	Tabular Zenith Distance of Star or of Limb of Moon.	Inferred Longitude West of Greenwich 10ʰ. 31ᵐ. +
h m s	h m s	° ′ ″	′ ″	′ ″	° ′ ″	° ′ ″	s
I. 22. 41. 4·72	23. 23. 34·09	97. 29. 10·5	60. 14·7	16. 26·6	42. 19. 16·95	51. 35. 21·2	
II. 22. 42. 4·55	23. 23. 36·28	97. 28. 53·7	60. 14·7	16. 26·6	42. 18. 44·10	51. 34. 45·0	16·6
I. 22. 50. 3·77	23. 23. 53·77	97. 26. 39·0	60. 15·0	16. 26·7	44. 29. 29·70	53. 20. 48·5	
II. 22. 51. 3·61	23. 23. 55·95	97. 26. 22·2	60. 15·0	16. 26·7	44. 28. 57·00	53. 20. 12·2	22·8
I. 22. 59. 0·67	23. 24. 13·36	97. 24. 8·1	60. 15·3	16. 26·8	46. 39. 11·40	55. 7. 26·8	
II. 23. 0. 0·50	23. 24. 15·55	97. 23. 51·3	60. 15·3	16. 26·8	46. 38. 38·55	55. 6. 50·4	22·4
I. 23. 16. 40·26	23. 24. 52·04	97. 19. 10·0	60. 15·9	16. 26·9	50. 55. 8·55	58. 41. 58·8	
II. 23. 17. 40·09	23. 24. 54·23	97. 18. 53·2	60. 15·9	16. 26·9	50. 54. 35·70	58. 41. 22·3	26·6
I. 0. 2. 4·69	0. 19. 12·41	90. 7. 15·1	60. 57·9	16. 38·4	49. 42. 9·60	54. 5. 59·6	
II. 0. 3. 4·52	0. 19. 14·61	90. 6. 57·3	60. 57·9	16. 38·4	49. 41. 36·60	54. 5. 22·2	7·5
I. 0. 16. 31·34	0. 19. 44·31	90. 2. 57·6	60. 58·2	16. 38·5	53. 11. 26·65	57. 13. 8·9	
II. 0. 17. 31·18	0. 19. 46·51	90. 2. 39·8	60. 58·2	16. 38·5	53. 10. 53·55	57. 12. 31·4	18·7
I. 0. 27. 5·34	0. 20. 7·65	89. 59. 49·2	60. 58·4	16. 38·6	55. 44. 32·55	59. 31. 7·9	
II. 0. 28. 5·18	0. 20. 9·84	89. 59. 31·4	60. 58·4	16. 38·6	55. 43. 59·70	59. 30. 30·7	22·9
I. 0. 53. 22·15	0. 21. 5·71	89. 52. 0·5	60. 59·0	16. 38·7	62. 5. 18·60	65. 17. 20·1	
II. 0. 54. 21·99	0. 21. 7·91	89. 51. 42·7	60. 59·0	16. 38·7	62. 4. 45·60	65. 16. 42·8	18·2
I. 1. 11. 51·46	0. 21. 46·56	89. 46. 30·7	60. 59·4	16. 38·9	66. 33. 10·95	69. 22. 49·3	
II. 1. 12. 51·30	0. 21. 48·77	89. 46. 12·9	60. 59·4	16. 38·9	66. 32. 37·80	69. 22. 11·8	17·4
I. 1. 33. 48·76	0. 22. 35·10	89. 39. 59·0	60. 59·9	16. 39·0	71. 51. 16·50	74. 15. 42·1	
II. 1. 34. 48·60	0. 22. 37·30	89. 39. 41·1	60. 59·9	16. 39·0	71. 50. 43·50	74. 15. 4·8	22·8
I. 23. 32. 57·29	1. 11. 47·69	83. 8. 17·8	61. 21·8	16. 44·9	30. 14. 25·95	33. 25. 55·1	
II. 23. 33. 57·12	1. 11. 49·96	83. 8. 0·2	61. 21·8	16. 44·9	30. 13. 51·90	33. 25. 17·1	22·6
I. 23. 42. 54·85	1. 12. 10·32	83. 5. 22·3	61. 21·9	16. 45·0	32. 38. 34·50	35. 31. 58·0	
II. 23. 43. 54·68	1. 12. 12·59	83. 5. 4·8	61. 21·9	16. 45·0	32. 38. 0·45	35. 31. 20·2	22·5
I. 23. 49. 20·53	1. 12. 24·93	83. 3. 29·1	61. 22·0	16. 45·0	34. 11. 36·45	36. 54. 13·4	
II. 23. 50. 20·37	1. 12. 27·20	83. 3. 11·6	61. 22·0	16. 45·0	34. 11. 2·40	36. 53. 35·5	19·6
I. 23. 55. 37·64	1. 12. 39·22	83. 1. 38·5	61. 22·1	16. 45·0	35. 42. 34·20	38. 15. 13·8	
II. 23. 56. 37·47	1. 12. 41·48	83. 1. 20·9	61. 22·1	16. 45·0	35. 42. 0·30	38. 14. 36·3	21·3
I. 0. 2. 51·29	1. 12. 55·58	82. 59. 31·0	61. 22·1	16. 45·0	37. 27. 11·40	39. 49. 1·4	
II. 0. 3. 51·13	1. 12. 57·85	82. 59. 13·4	61. 22·1	16. 45·0	37. 26. 37·35	39. 48. 23·3	29·6
I. 0. 9. 42·76	1. 13. 11·17	82. 57. 30·3	61. 22·2	16. 45·0	39. 6. 26·55	41. 18. 32·8	
II. 0. 10. 42·60	1. 13. 13·44	82. 57. 12·7	61. 22·2	16. 45·0	39. 5. 52·50	41. 17. 55·0	28·1
I. 0. 15. 50·73	1. 13. 25·13	82. 55. 42·3	61. 22·3	16. 45·0	40. 35. 11·85	42. 38. 59·6	
II. 0. 16. 50·57	1. 13. 27·39	82. 55. 24·8	61. 22·3	16. 45·0	40. 34. 37·95	42. 38. 21·7	30·4
I. 0. 21. 56·71	1. 13. 38·99	82. 53. 55·0	61. 22·3	16. 45·1	42. 3. 28·65	43. 59. 19·8	
II. 0. 22. 56·54	1. 13. 41·27	82. 53. 37·5	61. 22·3	16. 45·1	42. 2. 54·45	43. 58. 41·7	29·6

Day.	Observer.	Object.	Altazimuth-Clock Time of Vertical Transit over Mean of Horizontal Wires.	Lamp Right or Left.	Reading of Vertical Circle corrected for Runs of Micrometers.	Level Indication (additive).	Barometer and External Thermometer.	Refraction.	True observed Zenith Distance.
1874.			h m s		° ′ ″	″		″	° ′ ″
October 23	T	β Andromedæ...	4. 10. 35·30	R	226. 34. 54·3	68·6		52·6	43. 25. 11·0
		,, ...	4. 17. 34·48	R	225. 9. 20·6	67·9		55·3	44. 50. 48·1
	NI	Moon's L. L. ...	4. 39. 2·70	R	217. 32. 10·9	70·2		72·3	52. 28. 12·5
		,, ...	4. 47. 54·94	R	215. 33. 43·6	70·3		77·6	54. 26. 45·0
		,, ...	4. 57. 37·66	L	326. 34. 49·3	69·0	30in·16	84·2	56. 37. 1·2
		,, ...	5. 10. 52·24	L	329. 32. 18·0	69·8	72°·9	94·4	59. 34. 40·9
24	NI	Moon's L. L. ...	4. 7. 7·82	R	240. 33. 44·9	71·0	75°·5	31·2	29. 25. 56·6
		,, ...	4. 18. 46·16	R	237. 57. 57·6	71·0		34·6	32. 1. 47·3
		,, ...	4. 37. 35·72	R	233. 44. 57·3	71·4		40·5	36. 14. 53·1
		,, ...	4. 47. 50·44	L	308. 31. 41·7	67·6		44·1	38. 33. 12·1
		,, ...	5. 0. 21·84	L	311. 20. 40·7	69·0		48·7	41. 22. 17·1
		,, ...	5. 7. 26·74	L	312. 56. 20·8	69·4		51·5	42. 58. 0·4
		Procyon	5. 18. 20·14	L	305. 50. 44·3	72·6	30in·12	40·0	35. 52. 15·6
		,, ...	5. 26. 17·70	R	235. 50. 42·3	69·4	74°·8	37·6	34. 9. 7·2
25	T	Moon's U. L. ...	5. 8. 41·56	R	241. 54. 17·4	71·2	73°·0	29·6	28. 5. 22·3
		,, ...	5. 17. 28·24	R	239. 55. 24·0	71·1		32·1	30. 4. 18·3
		,, ...	5. 24. 13·74	R	238. 23. 57·9	70·9		34·1	31. 35. 46·6
		,, ...	5. 37. 5·32	L	304. 28. 22·1	69·4	30in·11	38·1	34. 29. 48·3
		,, ...	5. 45. 49·86	L	306. 26. 21·4	70·0	73°·4	40·9	36. 27. 51·0
		,, ...	6. 5. 42·88	L	310. 53. 58·0	70·6		48·0	40. 55. 35·3

October 24. The adopted Zenith point corresponding to the mean wire is 270. 0. 21·3.
October 25. " " " 270. 0. 21·3.

Greenwich Mean Solar Time, assuming the West Longitude to be I. 10h. 31m. 0s. II. 10h. 32m. 0s.		Tabular Geocentric Elements (R. A. and N. P. D. corrected). Apparent Right Ascension of Center.	Apparent North Polar Distance of Center.	Equatorial Horizontal Parallax.	Semi-diameter.	Hour-Angle.	Tabular Zenith Distance of Star or of Limb of Moon.	Inferred Longitude West of Greenwich 10h. 31m. +
	h m s	h m s	° ′ ″	′ ″	′ ″	° ′ ″	° ′ ″	s
	——	1. 2. 44·19	55. 2. 28·9	—	—	47. 15. 43·65	43. 25. 12·1	—
	——	,,	,,	—	—	49. 0. 31·80	44. 50. 47·6	—
I.	1. 0. 12·12	1. 15. 6·08	82. 42. 42·5	61. 22·7	16. 45·2	51. 17. 7·65	52. 28. 27·2	
II.	1. 1. 11·95	1. 15. 8·35	82. 42. 24·9	61. 22·7	16. 45·2	51. 16. 33·60	52. 27. 49·5	23·4
I.	1. 9. 2·92	1. 15. 26·23	82. 40. 7·1	61. 22·8	16. 45·2	53. 25. 9·30	54. 27. 4·3	
II.	1. 10. 2·76	1. 15. 28·50	82. 39. 49·6	61. 22·8	16. 45·2	53. 24. 35·25	54. 26. 26·5	30·6
I.	1. 18. 44·08	1. 15. 48·30	82. 37. 17·0	61. 22·9	16. 45·2	55. 45. 19·50	56. 37. 10·5	
II.	1. 19. 43·92	1. 15. 50·56	82. 36. 59·5	61. 22·9	16. 45·2	55. 44. 45·60	56. 36. 32·9	14·8
I.	1. 31. 56·53	1. 16. 18·40	82. 33. 25·2	61. 23·0	16. 45·3	58. 56. 27·15	59. 34. 51·9	
II.	1. 32. 56·36	1. 16. 20·67	82. 33. 7·7	61. 23·0	16. 45·3	58. 55. 53·10	59. 34. 14·2	17·5
I.	0. 24. 31·04	2. 9. 34·71	76. 6. 20·6	61. 26·6	16. 46·3	29. 42. 22·50	29. 26. 16·3	
II.	0. 25. 30·88	2. 9. 37·09	76. 6. 4·6	61. 26·6	16. 46·3	29. 41. 46·80	29. 25. 38·4	31·2
I.	0. 36. 7·51	2. 10. 2·38	76. 3. 13·9	61. 26·5	16. 46·3	32. 30. 3·15	32. 2. 2·7	
II.	0. 37. 7·35	2. 10. 4·75	76. 2. 57·8	61. 26·5	16. 46·3	32. 29. 27·60	32. 1. 25·0	24·5
I.	0. 54. 54·07	2. 10. 47·16	75. 58. 12·2	61. 26·5	16. 46·2	37. 1. 15·90	36. 15. 14·8	
II.	0. 55. 53·90	2. 10. 49·54	75. 57. 56·2	61. 26·5	16. 46·2	37. 0. 40·20	36. 14. 37·3	34·7
I.	1. 5. 7·14	2. 11. 11·55	75. 55. 28·3	61. 26·4	16. 46·2	39. 28. 51·45	38. 33. 27·0	
II.	1. 6. 6·98	2. 11. 13·93	75. 55. 12·3	61. 26·4	16. 46·2	39. 28. 15·75	38. 32. 49·0	23·5
I.	1. 17. 36·54	2. 11. 41·36	75. 52. 8·1	61. 26·4	16. 46·2	42. 29. 15·90	41. 22. 35·1	
II.	1. 18. 36·37	2. 11. 43·75	75. 51. 52·2	61. 26·4	16. 46·2	42. 28. 40·05	41. 21. 57·2	28·4
I.	1. 24. 40·30	2. 11. 58·24	75. 50. 15·0	61. 26·3	16. 46·2	44. 11. 16·65	42. 58. 16·9	
II.	1. 25. 40·14	2. 12. 0·62	75. 49. 59·1	61. 26·3	16. 46·2	44. 10. 40·95	42. 57. 39·2	26·3
	——	7. 32. 44·62	84. 27. 8·1	—	—	33. 16. 57·45	35. 52. 14·5	—
	——	,,	,,	—	—	31. 17. 33·60	34. 9. 9·7	—
I.	1. 22. 3·57	3. 10. 44·78	69. 58. 0·4	61. 9·2	16. 41·5	29. 49. 29·55	28. 5. 42·9	
II.	1. 23. 3·41	3. 10. 47·29	69. 57. 47·2	61. 9·2	16. 41·5	29. 48. 51·90	28. 5. 5·5	33·0
I.	1. 30. 48·85	3. 11. 6·83	69. 56. 5·0	61. 9·1	16. 41·5	31. 55. 39·45	30. 4. 39·2	
II.	1. 31. 48·69	3. 11. 9·35	69. 55. 51·8	61. 9·1	16. 41·5	31. 55. 1·65	30. 4. 2·4	34·1
I.	1. 37. 33·26	3. 11. 23·82	69. 54. 36·2	61. 8·9	16. 41·4	33. 32. 47·40	31. 36. 9·2	
II.	1. 38. 33·09	3. 11. 26·33	69. 54. 23·1	61. 8·9	16. 41·4	33. 32. 9·75	31. 35. 32·2	36·6
I.	1. 50. 22·77	3. 11. 56·15	69. 51. 47·7	61. 8·7	16. 41·4	36. 37. 36·75	34. 30. 2·0	
II.	1. 51. 22·60	3. 11. 58·66	69. 51. 34·6	61. 8·7	16. 41·4	36. 36. 59·10	34. 29. 25·0	22·2
I.	1. 59. 5·91	3. 12. 18·15	69. 49. 53·3	61. 8·5	16. 41·3	38. 43. 15·30	36. 28. 3·0	
II.	2. 0. 5·75	3. 12. 20·66	69. 49. 40·2	61. 8·5	16. 41·3	38. 42. 37·65	36. 27. 26·0	19·5
I.	2. 18. 55·74	3. 13. 8·19	69. 45. 33·9	61. 8·2	16. 41·2	43. 29. 1·05	40. 55. 51·8	
II.	2. 19. 55·58	3. 13. 10·71	69. 45. 20·4	61. 8·2	16. 41·2	43. 28. 23·25	40. 55. 14·6	26·6

October 24. The aperture of the telescope was reduced for some of the observations.

Day.	Observer.	Object.	Altazimuth-Clock Time of Vertical Transit over Mean of Horizontal Wires.	Lamp Right or Left.	Reading of Vertical Circle corrected for Runs of Micrometers.	Level Indication (additive).	Barometer and External Thermometer.	Refraction.	True observed Zenith Distance.
			h m s		° ′ ″	″		″	° ′ ″
1874. October 25	T	Moon's U. L. ...	6. 14. 2·08	L	312. 45. 45·3	70·6		51·2	42. 47. 25·8
		,, ...	6. 32. 50·24	R	223. 0. 58·1	71·1		59·3	46. 59. 11·4
		Aldebaran......	6. 42. 22·86	R	237. 42. 40·4	71·2	30in·11	35·0	32. 17. 4·7
		,, ...	7. 15. 39·20	R	229. 58. 5·7	71·2	74°·2	46·5	40. 1. 50·9
26	T	Moon's L. L. ...	0. 49. 43·80	R	225. 16. 4·9	66·6	73°·5	54·9	44. 44. 4·7
		,, ...	0. 58. 47·04	L	312. 42. 29·8	75·4		51·2	42. 44. 15·1
		,, ...	1. 21. 6·80	L	307. 46. 32·7	75·4		43·0	37. 48. 9·8
		,, ...	1. 27. 56·04	L	306. 15. 59·3	75·6		40·7	36. 17. 34·3
		,, ...	1. 34. 33·22	R	235. 10. 20·0	66·0		38·5	34. 49. 33·8
		,, ...	1. 40. 9·26	R	236. 24. 46·8	65·5		36·8	33. 35. 5·8
		Aldebaran......	1. 49. 59·82	R	232. 31. 1·6	66·0		42·5	37. 28. 56·2
		,, ...	1. 55. 49·92	R	233. 52. 32·6	66·0		40·4	36. 7. 23·1
		,, ...	2. 3. 38·16	L	304. 16. 53·0	73·1	30in·16	37·8	34. 18. 22·6
		,, ...	2. 11. 26·50	L	302. 27. 56·9	74·0	73°·6	35·3	32. 29. 24·9
	NI	Moon's U. L. ...	5. 46. 38·14	L	291. 55. 31·7	69·8		22·3	21. 56. 42·5
		,, ...	5. 57. 25·16	L	294. 18. 13·6	70·0		25·0	24. 19. 27·3
		,, ...	6. 6. 59·08	L	296. 24. 49·3	70·8		27·5	26. 26. 6·3
		,, ...	6. 16. 13·38	R	241. 31. 13·3	72·0		30·0	28. 28. 26·0
		,, ...	6. 25. 9·86	R	239. 32. 56·6	71·2		32·6	30. 26. 46·1
		,, ...	6. 33. 36·88	R	237. 41. 15·4	70·6		35·0	32. 18. 30·3
		Procyon	6. 53. 46·66	R	251. 48. 18·0	70·0	30in·13	18·2	18. 11. 11·5
		,, ...	7. 4. 11·00	L	287. 2. 48·8	66·2	72°·5	17·0	17. 3. 50·7

October 26. The adopted Zenith point corresponding to the mean wire is 270° 0′ 21″·3

Greenwich Mean Solar Time, assuming the West Longitude to be I. 10h. 31m. 0s. II. 10h. 32m. 0s.	Tabular Geocentric Elements (R. A. and N. P. D. corrected). Apparent Right Ascension of Center.	Apparent North Polar Distance of Center.	Equatorial Horizontal Parallax.	Semi-diameter.	Hour-Angle.	Tabular Zenith Distance of Star or of Limb of Moon.	Inferred Longitude West of Greenwich 10h. 31m. +
h. m. s.	h. m. s.	° ′ ″	′ ″	′ ″	° ′ ″	° ′ ″	s.
I. 2. 27. 13·61	3. 13. 29·14	69. 43. 45·6	61. 8·0	16. 41·2	45. 28. 35·25	42. 47. 37·9	
II. 2. 28. 13·45	3. 13. 31·66	69. 43. 32·6	61. 8·0	16. 41·2	45. 27. 57·45	42. 47. 0·8	19·0
I. 2. 45. 58·73	3. 14. 16·50	69. 39. 41·6	61. 7·6	16. 41·1	49. 58. 48·00	46. 59. 33·0	
II. 2. 46. 58·57	3. 14. 19·02	69. 39. 28·6	61. 7·6	16. 41·1	49. 58. 10·20	46. 58. 55·9	34·9
——	4. 28. 44·81	73. 44. 29·4	—	—	33. 44. 53·25	32. 17. 3·0	—
——	,,	,,	—	—	42. 4. 0·00	40. 1. 52·2	—
I. 20. 59. 56·37	4. 1. 11·40	66. 8. 42·5	60. 41·7	16. 34·0	47. 30. 35·25	44. 43. 46·6	
II. 21. 0. 56·20	4. 1. 14·01	66. 8. 32·5	60. 41·7	16. 34·0	47. 31. 14·40	44. 44. 21·0	31·6
I. 21. 8. 58·14	4. 1. 35·02	66. 7. 11·8	60. 41·4	16. 33·9	45. 20. 40·65	42. 43. 57·5	
II. 21. 9. 57·98	4. 1. 37·63	66. 7. 1·7	60. 41·4	16. 33·9	45. 21. 19·80	42. 44. 32·1	30·5
I. 21. 31. 14·31	4. 2. 33·31	66. 3. 29·2	60. 40·8	16. 33·8	40. 0. 17·70	37. 47. 51·3	
II. 21. 32. 14·14	4. 2. 35·93	66. 3. 19·3	60. 40·8	16. 33·8	40. 0. 57·00	37. 48. 26·3	31·7
I. 21. 38. 2·46	4. 2. 51·13	66. 2. 21·5	60. 40·6	16. 33·7	38. 22. 26·10	36. 17. 15·6	
II. 21. 39. 2·30	4. 2. 53·73	66. 2. 11·6	60. 40·6	16. 33·7	38. 23. 5·10	36. 17. 50·5	32·1
I. 21. 44. 38·58	4. 3. 8·41	66. 1. 15·9	60. 40·5	16. 33·65	36. 47. 27·30	34. 49. 16·8	
II. 21. 45. 38·41	4. 3. 11·03	66. 1. 6·0	60. 40·5	16. 33·65	36. 48. 6·60	34. 49. 52·2	28·8
I. 21. 50. 13·71	4. 3. 23·04	66. 0. 20·5	60. 40·3	16. 33·6	35. 27. 5·85	33. 34. 48·9	
II. 21. 51. 13·55	4. 3. 25·65	66. 0. 10·6	60. 40·3	16. 33·6	35. 27. 45·00	33. 35. 24·0	28·9
——	4. 28. 44·83	73. 44. 29·4	—	—	39. 19. 54·00	37. 28. 59·0	—
——	,,	,,	—	—	37. 52. 22·20	36. 7. 26·6	—
——	,,	,,	—	—	35. 55. 18·30	34. 18. 25·9	—
——	,,	,,	—	—	33. 58. 12·90	32. 29. 27·0	—
I. 1. 56. 2·95	4. 14. 8·96	65. 21. 13·1	60. 33·2	16. 31·7	23. 28. 49·50	21. 57. 0·3	
II. 1. 57. 2·78	4. 14. 11·58	65. 21. 4·0	60. 33·2	16. 31·7	23. 28. 10·20	21. 56. 24·8	30·1
I. 2. 6. 48·23	4. 14. 37·30	65. 19. 34·6	60. 32·9	16. 31·6	26. 3. 30·15	24. 19. 44·1	
II. 2. 7. 48·07	4. 14. 39·93	65. 19. 25·5	60. 32·9	16. 31·6	26. 2. 50·70	24. 19. 8·8	28·6
I. 2. 16. 20·60	4. 15. 2·46	65. 18. 7·6	60. 32·6	16. 31·5	28. 20. 41·85	26. 26. 22·0	
II. 2. 17. 20·44	4. 15. 5·09	65. 17. 58·4	60. 32·6	16. 31·5	28. 20. 2·40	26. 25. 46·8	26·8
I. 2. 25. 33·42	4. 15. 26·75	65. 16. 43·7	60. 32·3	16. 31·4	30. 33. 12·45	28. 28. 39·3	
II. 2. 26. 33·25	4. 15. 29·38	65. 16. 34·7	60. 32·3	16. 31·4	30. 32. 33·00	28. 28. 3·6	22·3
I. 2. 34. 28·47	4. 15. 50·27	65. 15. 22·8	60. 32·1	16. 31·4	32. 41. 27·45	30. 26. 57·4	
II. 2. 35. 28·31	4. 15. 52·89	65. 15. 13·8	60. 32·1	16. 31·4	32. 40. 48·15	30. 26. 21·7	19·0
I. 2. 42. 54·14	4. 16. 12·50	65. 14. 6·6	60. 31·8	16. 31·3	34. 42. 39·75	32. 18. 41·0	
II. 2. 43. 53·97	4. 16. 15·13	65. 13. 57·6	60. 31·8	16. 31·3	34. 42. 0·30	32. 18. 5·0	17·8
——	7. 32. 44·68	84. 27. 8·3	—	—	9. 22. 55·35	18. 11. 12·8	—
——	,,	,,	—	—	6. 46. 49·80	17. 4. 1·3	—

October 26. The aperture of the telescope was reduced for some of the observations.

Day.	Observer.	Object.	Altazimuth-Clock Time of Vertical Transit over Mean of Horizontal Wires.	Lamp Right or Left.	Reading of Vertical Circle corrected for Runs of Micrometers.	Level Indication (additive).	Barometer and External Thermometer.	Refraction.	True observed Zenith Distance.
1874.			h m s		° ′ ″	″		″	° ′ ″
October 27	T	Moon's L. L. ...	1. 15. 52·72	R	216. 55. 9·4	64·8		73·7	53. 5. 18·8
		,, ...	1. 22. 42·96	R	218. 22. 48·0	65·3		69·9	51. 37. 35·9
		,, ...	1. 53. 35·06	L	314. 58. 23·0	75·8	30in·20	55·4	45. 0. 14·9
		,, ...	2. 0. 35·46	L	313. 27. 59·4	76·0	74°·0	52·6	43. 29. 48·7
	NI	Moon's U. L. ...	7. 1. 9·08	R	246. 1. 10·0	69·8	73°·7	24·7	23. 58. 24·2
		,, ...	7. 9. 29·22	R	244. 14. 41·5	69·8		26·7	25. 44. 54·7
		,, ...	7. 17. 34·88	R	242. 30. 58·0	69·7		28·8	27. 28. 40·4
		Capella	7. 29. 26·92	R	231. 50. 45·3	66·2		43·5	38. 9. 11·3
		,, ...	7. 37. 33·02	L	309. 23. 14·1	72·6		45·5	39. 24. 52·9
		Moon's U. L. ...	7. 47. 18·88	L	303. 49. 39·8	70·9		37·2	33. 51. 8·6
		,, ...	7. 54. 57·12	L	305. 28. 3·5	71·2	30in·17	39·5	35. 29. 34·9
		,, ...	8. 2. 48·14	L	307. 9. 9·4	71·2	73°·6	42·0	37. 10. 43·3
28	NI	Moon's L. L. ...	2. 41. 51·82	R	221. 6. 39·2	62·4	72°·6	63·5	48. 53. 41·7
		,, ...	2. 48. 30·68	R	222. 31. 23·1	62·4		60·5	47. 28. 54·8
		,, ...	2. 54. 13·28	R	223. 44. 12·7	63·2		58·0	46. 16. 1·9
		,, ...	3. 3. 51·02	L	314. 11. 15·9	76·8		54·0	44. 13. 6·9
		,, ...	3. 26. 14·30	L	309. 25. 0·3	77·0	30in·15	45·6	39. 26. 43·1
		,, ...	3. 48. 5·44	L	304. 45. 32·6	77·2		38·5	34. 47. 8·5
		Procyon	3. 58. 51·22	L	323. 38. 58·9	74·7		75·3	53. 41. 9·1
		,, ...	4. 8. 58·36	R	218. 38. 39·9	65·6	72°·7	69·3	51. 21. 43·6

October 27. The adopted Zenith point corresponding to the mean wire is 270. 0. 19·3 (° ′ ″)
October 28. " " " 270. 0. 19·8

Greenwich Mean Solar Time, assuming the West Longitude to be I. $10^h. 31^m. 0^s$. II. $10^h. 32^m. 0^s$.	Tabular Geocentric Elements (R. A. and N. P. D. corrected). Apparent Right Ascension of Center.	Apparent North Polar Distance of Center.	Equatorial Horizontal Parallax.	Semi-diameter.	Hour-Angle.	Tabular Zenith Distance of Star or of Limb of Moon.	Inferred Longitude West of Greenwich $10^h. 31^m.$ +
h m s	h m s	° ′ ″	′ ″	′ ″	° ′ ″	° ′ ″	s
I. 21. 22. 9·46	5. 5. 54·47	62. 58. 31·6	59. 54·5	16. 21·1	57. 8. 1·95	53. 5. 10·8	
II. 21. 23. 9·29	5. 5. 57·15	62. 58. 26·2	59. 54·5	16. 21·1	57. 8. 42·15	53. 5. 45·8	13·7
I. 21. 28. 58·59	5. 6. 12·77	62. 57. 54·5	59. 54·3	16. 21·0	55. 30. 2·55	51. 37. 27·3	
II. 21. 29. 58·43	5. 6. 15·44	62. 57. 49·1	59. 54·3	16. 21·0	55. 30. 42·60	51. 38. 2·1	14·8
I. 21. 59. 45·75	5. 7. 35·34	62. 55. 8·7	59. 53·2	16. 20·7	48. 7. 37·95	45. 0. 2·3	
II. 22. 0. 45·59	5. 7. 38·02	62. 55. 3·4	59. 53·2	16. 20·7	48. 8. 18·15	45. 0. 37·8	21·3
I. 22. 6. 45·03	5. 7. 54·09	62. 54. 31·5	59. 52·9	16. 20·6	46. 27. 12·75	43. 29. 35·2	
II. 22. 7. 44·87	5. 7. 56·76	62. 54. 26·2	59. 52·9	16. 20·6	46. 27. 52·80	43. 30. 10·6	22·9
I. 3. 6. 30·34	5. 21. 18·59	62. 30. 26·0	59. 41·9	16. 17·6	25. 20. 18·00	23. 58. 36·3	
II. 3. 7. 30·18	5. 21. 21·27	62. 30. 21·7	59. 41·9	16. 17·6	25. 19. 37·80	23. 58. 2·0	21·2
I. 3. 14. 49·16	5. 21. 40·91	62. 29. 50·2	59. 41·6	16. 17·5	27. 19. 45·90	25. 45. 6·7	
II. 3. 15. 49·00	5. 21. 43·59	62. 29. 45·9	59. 41·6	16. 17·5	27. 19. 5·70	25. 44. 32·3	20·9
I. 3. 22. 53·51	5. 22. 2·58	62. 29. 15·7	59. 41·3	16. 17·5	29. 15. 46·05	27. 28. 50·3	
II. 3. 23. 53·34	5. 22. 5·26	62. 29. 11·4	59. 41·3	16. 17·5	29. 15. 5·85	27. 28. 15·4	17·0
——	5. 7. 27·19	44. 7. 51·9	—	—	35. 52. 38·10	38. 9. 8·0	—
——	,,	,,	—	—	37. 54. 10·05	39. 24. 41·6	—
I. 3. 52. 32·74	5. 23. 22·18	62. 27. 10·6	59. 40·2	16. 17·2	36. 21. 53·55	33. 51. 18·6	
II. 3. 53. 32·57	5. 23. 24·86	62. 27. 6·4	59. 40·2	16. 17·2	36. 21. 13·35	33. 50. 43·3	17·0
I. 4. 0. 9·74	5. 23. 42·63	62. 26. 38·9	59. 39·9	16. 17·1	38. 11. 20·55	35. 29. 42·1	
II. 4. 1. 9·57	5. 23. 45·30	62. 26. 34·8	59. 39·9	16. 17·1	38. 10. 40·50	35. 29. 6·8	12·2
I. 4. 7. 59·51	5. 24. 3·64	62. 26. 6·6	59. 39·7	16. 17·0	40. 3. 51·15	37. 10. 50·8	
II. 4. 8. 59·34	5. 24. 6·32	62. 26. 2·5	59. 39·7	16. 17·0	40. 3. 10·95	37. 10. 15·1	12·6
I. 22. 44. 3·66	6. 13. 46·16	61. 43. 47·5	58. 56·2	16. 5·2	52. 34. 54·15	48. 53. 30·7	
II. 22. 45. 3·49	6. 13. 48·80	61. 43. 47·1	58. 56·2	16. 5·2	52. 35. 33·75	48. 54. 5·4	19·0
I. 22. 50. 41·45	6. 14. 3·74	61. 43. 44·6	58. 56·0	16. 5·2	50. 59. 34·65	47. 28. 45·4	
II. 22. 51. 41·29	6. 14. 6·38	61. 43. 44·2	58. 56·0	16. 5·2	51. 0. 14·25	47. 29. 20·2	16·2
I. 22. 56. 23·15	6. 14. 18·82	61. 43. 42·2	58. 55·7	16. 5·1	49. 37. 41·40	46. 15. 52·6	
II. 22. 57. 22·99	6. 14. 21·47	61. 43. 41·8	58. 55·7	16. 5·1	49. 38. 21·15	46. 16. 27·8	15·9
I. 23. 5. 39·33	6. 14. 44·27	61. 43. 38·4	58. 55·4	16. 5·0	47. 19. 36·75	44. 12. 52·6	
II. 23. 6. 59·17	6. 14. 46·91	61. 43. 38·0	58. 55·4	16. 5·0	47. 20. 16·35	44. 13. 27·5	24·6
I. 23. 28. 19·03	6. 15. 43·41	61. 43. 30·6	58. 54·4	16. 4·7	41. 58. 33·45	39. 26. 29·5	
II. 23. 29. 18·86	6. 15. 46·05	61. 43. 30·3	58. 54·4	16. 4·7	41. 59. 13·05	39. 27. 4·2	23·5
I. 23. 50. 6·64	6. 16. 41·10	61. 43. 24·6	58. 53·6	16. 4·5	36. 45. 10·80	34. 46. 53·5	
II. 23. 51. 6·48	6. 16. 43·74	61. 43. 24·3	58. 53·6	16. 4·5	36. 45. 50·40	34. 47. 28·2	25·9
——	7. 32. 44·74	84. 27. 8·5	—	—	53. 4. 38·10	53. 41. 12·4	—
——	,,	,,	—	—	50. 32. 50·55	51. 21. 48·0	—

Day.	Observer.	Object.	Altazimuth-Clock Time of Vertical Transit over Mean of Horizontal Wires.	Lamp Right or Left.	Reading of Vertical Circle corrected for Runs of Micrometers.	Level Indication (additive).	Barometer and External Thermometer.	Refraction.	True observed Zenith Distance.
1874.			h m s		° ′ ″	″		″	° ′ ″
October 29	NI	Moon's L. L. ...	4. 10. 16·50	R	226. 8. 21·7	61·8	72°·9	53·2	43. 51. 49·5
		,, ...	4. 20. 23·84	R	228. 18. 55·8	61·4		49·3	41. 41. 11·9
		,, ...	4. 32. 27·22	R	230. 54. 35·0	61·5		45·0	39. 5. 28·3
		,, ...	4. 47. 32·40	L	305. 48. 44·7	78·0		40·0	35. 50. 22·9
		,, ...	4. 55. 52·98	L	304. 0. 54·7	78·8		37·4	34. 2. 31·1
		,, ...	5. 4. 9·36	L	302. 13. 59·4	79·0		35·0	32. 15. 33·6
		Procyon........	5. 24. 31·40	L	304. 25. 25·7	75·2	30in·05	38·0	34. 26. 59·1
		,, ...	5. 54. 1·44	R	241. 42. 4·5	66·0	72°·0	29·8	28. 17. 39·1
November 4	T	Moon's L. L. ...	8. 16. 32·00	R	206. 27. 37·1	66·0		111·1	63. 33. 28·4
		,, ...	8. 27. 50·90	R	208. 57. 25·1	64·8	30in·10	100·1	61. 3. 30·6
		,, ...	9. 1. 0·22	L	323. 46. 48·1	74·4	71°·0	75·8	53. 48. 57·9
5	NI	Moon's L. L. ...	8. 42. 18·18	L	340. 10. 45·1	76·8	30in·12	152·5	70. 14. 14·0
		,, ...	8. 54. 19·26	R	202. 23. 51·1	61·6	73°·7	133·5	67. 37. 41·2
14	NI	Moon's L. L. ...	0. 13. 38·40	L	344. 38. 1·6	54·2		199·6	74. 41. 55·0
		,, ...	0. 55. 12·50	R	187. 38. 58·4	88·0		389·6	82. 26. 23·6
		,, ...	1. 3. 55·44	R	186. 0. 4·9	87·8	30in·12	482·2	84. 6. 49·9
		,, ...	1. 12. 39·28	L	355. 37. 21·3	51·8	70°·7	631·1	85. 48. 23·8
15	NI	Moon's L. L. ...	0. 45. 35·60	L	338. 5. 5·4	52·6	66°·2	138·3	68. 7. 55·9

October 29. The adopted Zenith point corresponding to the mean wire is 270. 0. 19·8 (° ′ ″)
November 4 to November 15. The adopted Zenith point corresponding to the mean wire is 270°. 0′. 20″·4

Greenwich Mean Solar Time, assuming the West Longitude to be I. 10h. 31m. 0s. II. 10h. 32m. 0s.	Tabular Geocentric Elements (R. A. and N. P. D. corrected). Apparent Right Ascension of Center.	Apparent North Polar Distance of Center.	Equatorial Horizontal Parallax.	Semi-diameter.	Hour-Angle.	Tabular Zenith Distance of Star or of Limb of Moon.	Inferred Longitude West of Greenwich 10h. 31m. +
h m s	h m s	° ′ ″	′ ″	′ ″	° ′ ″	° ′ ″	s
I. 0. 8. 22·90	7. 19. 36·19	62. 31. 45·9	57. 55·1	15. 48·5	46. 55. 0·15	43. 51. 38·7	
II. 0. 9. 22·74	7. 19. 38·68	62. 31. 50·0	57. 55·1	15. 48·5	46. 55. 37·50	43. 52. 11·9	19·5
I. 0. 18. 28·61	7. 20. 1·60	62. 32. 27·5	57. 54·7	15. 48·4	44. 29. 30·75	41. 41. 1·7	
II. 0. 19. 28·44	7. 20. 4·11	62. 32. 31·7	57. 54·7	15. 48·4	44. 30. 8·40	41. 41. 35·0	18·4
I. 0. 30. 30·04	7. 20. 31·85	62. 33. 17·5	57. 54·2	15. 48·3	41. 36. 13·35	39. 5. 16·6	
II. 0. 31. 29·88	7. 20. 34·36	62. 33. 21·7	57. 54·2	15. 48·3	41. 36. 51·00	39. 5. 49·8	21·1
I. 0. 45. 32·79	7. 21. 9·69	62. 34. 20·6	57. 53·6	15. 48·1	37. 59. 22·50	35. 50. 12·8	
II. 0. 46. 32·63	7. 21. 12·20	62. 34. 24·8	57. 53·6	15. 48·1	38. 0. 0·15	35. 50. 46·1	18·2
I. 0. 53. 52·01	7. 21. 30·60	62. 34. 55·8	57. 53·3	15. 48·0	35. 59. 27·45	34. 2. 20·0	
II. 0. 54. 51·85	7. 21. 33·11	62. 35. 0·0	57. 53·3	15. 48·0	36. 0. 5·10	34. 2. 53·1	20·1
I. 1. 2. 7·09	7. 21. 51·33	62. 35. 30·8	57. 52·9	15. 47·9	34. 0. 31·95	32. 15. 22·2	
II. 1. 3. 6·93	7. 21. 53·84	62. 35. 35·1	57. 52·9	15. 47·9	34. 1. 9·60	32. 15. 55·3	20·7
——	7. 32. 44·78	84. 27. 8·6	—	—	31. 38. 22·35	34. 27. 2·3	—
——	,,	,,	—	—	24. 15. 50·25	28. 17. 37·8	—
I. 3. 50. 47·41	12. 19. 50·02	89. 58. 15·8	54. 8·7	14. 46·8	60. 18. 21·60	63. 33. 21·2	
II. 3. 51. 47·25	12. 19. 51·76	89. 58. 29·9	54. 8·7	14. 46·8	60. 18. 47·70	63. 33. 50·8	14·6
I. 4. 2. 4·50	12. 20. 9·69	90. 0. 54·4	54. 8·6	14. 46·7	57. 33. 32·55	61. 3. 20·1	
II. 4. 3. 4·34	12. 20. 11·42	90. 1. 8·5	54. 8·6	14. 46·7	57. 33. 58·50	61. 3. 49·7	21·3
I. 4. 35. 8·47	12. 21. 7·30	90. 8. 39·2	54. 8·3	14. 46·6	49. 30. 35·55	53. 48. 47·9	
II. 4. 36. 8·31	12. 21. 9·03	90. 8. 53·3	54. 8·3	14. 46·6	49. 31. 1·50	53. 49. 17·4	20·3
I. 4. 10. 24·42	13. 2. 16·64	95. 37. 34·8	53. 59·6	14. 44·2	65. 0. 49·20	70. 14. 4·4	
II. 4. 11. 24·25	13. 2. 18·39	95. 37. 48·5	53. 59·6	14. 44·2	65. 1. 15·45	70. 14. 33·9	19·5
I. 4. 22. 23·52	13. 2. 37·66	95. 40. 19·8	53. 59·6	14. 44·2	62. 5. 48·30	67. 37. 30·9	
II. 4. 23. 23·36	13. 2. 39·41	95. 40. 33·5	53. 59·6	14. 44·2	62. 6. 14·55	67. 38. 0·3	23·2
I. 19. 7. 54·39	20. 18. 23·26	115. 0. 47·0	56. 27·6	15. 24·6	58. 49. 59·55	74. 42. 7·5	
II. 19. 8. 54·22	20. 18. 25·56	115. 0. 39·6	56. 27·6	15. 24·6	58. 49. 25·05	74. 41. 37·4	24·9
I. 19. 49. 21·72	20. 19. 58·46	114. 55. 33·5	56. 28·8	15. 25·0	68. 49. 43·65	82. 26. 35·5	
II. 19. 50. 21·56	20. 20. 0·75	114. 55. 25·9	56. 28·8	15. 25·0	68. 49. 9·30	82. 26. 4·5	23·0
I. 19. 58. 3·25	20. 20. 18·34	114. 54. 27·2	56. 29·0	15. 25·0	70. 55. 29·70	84. 7. 0·7	
II. 19. 59. 3·08	20. 20. 20·69	114. 54. 19·6	56. 29·0	15. 25·0	70. 54. 54·45	84. 6. 28·9	20·4
I. 20. 6. 45·67	20. 20. 38·39	114. 53. 20·6	56. 29·3	15. 25·1	73. 1. 26·70	85. 48. 28·8	
II. 20. 7. 45·50	20. 20. 40·68	114. 53. 12·9	56. 29·3	15. 25·1	73. 0. 52·35	85. 47. 57·5	9·6
I. 19. 35. 51·38	21. 13. 44·99	111. 16. 35·4	57. 11·6	15. 36·6	52. 59. 5·55	68. 8. 7·6	
II. 19. 36. 51·22	21. 13. 47·21	111. 16. 24·7	57. 11·6	15. 36·6	52. 58. 32·25	68. 7. 36·3	22·4

November 4. Cloudy. Observations unsatisfactory.

Day.	Observer.	Object.	Altazimuth-Clock Time of Vertical Transit over Mean of Horizontal Wires.	Lamp Right or Left.	Reading of Vertical Circle corrected for Runs of Micrometers.	Level Indication (additive).	Barometer and External Thermometer.	Refraction.	True observed Zenith Distance.
1874.			h m s		° ′ ″	″		″	° ′ ″
November 15	NI	Moon's L. L. ...	0. 55. 42·20	L	339. 55. 28·5	52·6		152·2	69. 58. 32·9
		,, ...	1. 2. 54·80	L	341. 15. 21·8	52·6		163·7	71. 18. 37·7
		,, ...	1. 16. 38·70	R	196. 8. 28·4	89·8		191·0	73. 53. 33·2
		,, ...	1. 26. 20·46	R	194. 17. 47·4	89·6		216·2	75. 44. 39·6
		,, ...	1. 37. 16·54	R	192. 11. 25·0	89·1		253·4	77. 51. 39·7
		δ Capricorni	1. 46. 49·98	R	198. 36. 43·2	88·8	30in·08	165·1	71. 24. 53·5
		,, ...	1. 56. 45·54	L	343. 25. 20·9	51·2	64°·2	186·6	73. 28. 58·3
16	NI	Moon's L. L. ...	1. 35. 15·16	L	334. 17. 12·9	69·9	66°·7	115·4	64. 19. 57·8
		,, ...	1. 44. 10·64	L	335. 59. 5·2	70·4		124·6	66. 1. 59·8
		,, ...	1. 55. 4·70	R	201. 52. 59·5	71·6		137·9	68. 8. 27·2
		,, ...	2. 3. 21·58	R	200. 15. 48·5	71·0		149·9	69. 45. 50·8
		,, ...	2. 13. 15·66	L	341. 39. 57·5	69·1		167·0	71. 43. 33·2
		,, ...	2. 23. 35·40	L	343. 43. 45·1	70·3		189·1	73. 47. 44·1
		,, ...	2. 32. 33·48	R	194. 26. 3·8	71·8		213·2	75. 36. 38·0
		,, ...	2. 41. 7·26	R	192. 41. 43·4	70·4		242·6	77. 21. 29·2
		Fomalhaut	2. 54. 20·40	R	192. 2. 44·8	67·6	30in·03	255·4	78. 0. 43·4
		,, ...	3. 13. 6·56	L	351. 19. 33·7	71·4	65°·1	350·5	81. 26. 15·2
22	NI	α Arietis	4. 9. 44·14	L	300. 1. 19·8	84·8		32·5	30. 2. 54·7
		,, ...	4. 35. 7·58	R	234. 7. 14·9	56·0		40·6	35. 52. 52·1
		Moon's L. L. ...	4. 48. 13·30	R	252. 54. 46·9	57·4		17·3	17. 4. 55·4
		,, ...	5. 0. 40·34	R	250. 6. 35·2	58·3	65°·7	20·3	19. 53. 9·2

		° ′ ″
November 15 and 16.	The adopted Zenith point corresponding to the mean wire is	270. 0. 20·4
November 22.	,, ,, ,,	270. 0. 22·4

Greenwich Mean Solar Time, assuming the West Longitude to be I. 10h. 31m. 0s. II. 10h. 32m. 0s.	Tabular Geocentric Elements (R. A. and N. P. D. corrected). Apparent Right Ascension of Center.	Apparent North Polar Distance of Center.	Equatorial Horizontal Parallax.	Semi-diameter.	Hour-Angle.	Tabular Zenith Distance of Star or of Limb of Moon.	Inferred Longitude West of Greenwich 10h. 31m. +
h m s	h m s	° ′ ″	′ ″	′ ″	° ′ ″	° ′ ″	s
I. 19. 45. 56·33	21. 14. 7·44	111. 14. 47·2	57. 11·9	15. 36·7	55. 25. 7·95	69. 58. 44·8	
II. 19. 46. 56·17	21. 14. 9·66	111. 14. 36·4	57. 11·9	15. 36·7	55. 24. 34·65	69. 58. 13·1	22·5
I. 19. 53. 7·77	21. 14. 23·45	111. 13. 29·8	57. 12·1	15. 36·7	57. 9. 17·10	71. 18. 48·0	
II. 19. 54. 7·61	21. 14. 25·67	111. 13. 19·1	57. 12·1	15. 36·7	57. 8. 43·80	71. 18. 16·2	19·4
I. 20. 6. 49·44	21. 14. 53·93	111. 11. 2·2	57. 12·6	15. 36·9	60. 27. 38·70	73. 53. 43·5	
II. 20. 7. 49·28	21. 14. 56·15	111. 10. 51·5	57. 12·6	15. 36·9	60. 27. 5·40	73. 53. 11·5	19·3
I. 20. 16. 29·62	21. 15. 15·45	111. 9. 17·8	57. 12·9	15. 36·9	62. 47. 42·45	75. 44. 54·0	
II. 20. 17. 29·46	21. 15. 17·66	111. 9. 7·0	57. 12·9	15. 36·9	62. 47. 9·30	75. 44. 21·9	26·9
I. 20. 27. 23·94	21. 15. 39·70	111. 7. 19·7	57. 13·2	15. 37·0	65. 25. 40·20	77. 51. 53·4	
II. 20. 28. 23·78	21. 15. 41·92	111. 7. 8·9	57. 13·2	15. 37·0	65. 25. 6·90	77. 51. 21·1	25·4
——	21. 40. 7·47	106. 41. 46·1	—	—	61. 42. 5·55	71. 24. 54·9	—
——	,,	,,	—	—	64. 10. 59·25	73. 29. 1·3	—
I. 20. 21. 27·55	22. 8. 0·04	106. 16. 2·9	58. 0·6	15. 50·0	51. 50. 22·95	64. 20. 7·0	
II. 20. 22. 27·38	22. 8. 2·21	106. 15. 49·4	58. 0·6	15. 50·0	51. 49. 50·40	64. 19. 33·7	16·6
I. 20. 30. 21·57	22. 8. 19·25	106. 14. 3·0	58. 0·9	15. 50·1	53. 59. 27·15	66. 2. 9·0	
II. 20. 31. 21·41	22. 8. 21·40	106. 13. 49·6	58. 0·9	15. 50·1	53. 58. 54·90	66. 1. 35·9	16·7
I. 20. 41. 13·86	22. 8. 42·70	106. 11. 36·6	58. 1·2	15. 50·2	56. 37. 6·45	68. 8. 39·9	
II. 20. 42. 13·70	22. 8. 44·86	106. 11. 23·1	58. 1·2	15. 50·2	56. 36. 34·05	68. 8. 6·2	22·6
I. 20. 49. 29·39	22. 9. 0·52	106. 9 45·1	58. 1·5	15. 50·2	58. 36. 52·50	69. 46. 2·1	
II. 20. 50. 29·23	22. 9. 2·68	106. 9. 31·7	58. 1·5	15. 50·2	58. 36. 20·10	69. 45. 28·5	20·2
I. 20. 59. 21·85	22. 9. 21·82	106. 7. 31·8	58. 1·9	15. 50·3	61. 0. 4·20	71. 43. 45·7	
II. 21. 0. 21·69	22. 9. 23·96	106. 7. 18·3	58. 1·9	15. 50·3	60. 59. 32·10	71. 43. 12·3	22·5
I. 21. 9. 39·91	22. 9. 44·03	106. 5. 12·5	58. 2·2	15. 50·4	63. 29. 27·30	73. 47. 58·1	
II. 21. 10. 39·75	22. 9. 46·18	106. 4. 59·0	58. 2·2	15. 50·4	63. 28. 55·05	73. 47. 24·4	24·9
I. 21. 18. 36·53	22. 10. 3·31	106. 3. 11·5	58. 2·5	15. 50·5	65. 39. 9·45	75. 36. 51·7	
II. 21. 19. 36·36	22. 10. 5·46	106. 2. 58·0	58. 2·5	15. 50·5	65. 38. 37·20	75. 36. 18·1	24·5
I. 21. 27. 8·91	22. 10. 21·73	106. 1. 15·8	58. 2·8	15. 50·6	67. 43. 0·00	77. 21. 40·5	
II. 20. 28. 8·75	22. 10. 23·87	106. 1. 2·2	58. 2·8	15. 50·6	67. 42. 27·90	77. 21. 6·9	20·2
——	22. 50. 44·09	120. 17. 16·4	—	—	60. 55. 41·85	78. 0. 39·6	—
——	,,	,,	—	—	65. 37. 14·40	81. 26. 14·5	—
——	2. 0. 7·89	67. 7. 39·8	—	—	32. 26. 50·85	30. 2. 52·5	—
——	,,	,,	—	—	38. 47. 42·75	35. 52. 49·3	—
I. 23. 10. 23·35	3. 37. 23·02	67. 49. 29·4	61. 3·5	16. 39·9	17. 45. 21·75	17. 5. 1·7	
II. 23. 11. 23·18	3. 37. 25·60	67. 49. 17·9	61. 3·5	16. 39·9	17. 44. 43·05	17. 4. 27·1	10·9
I. 23. 22. 48·39	3. 37. 55·18	67. 47. 5·5	61. 3·4	16. 39·9	20. 44. 5·10	19. 53. 18·7	
II. 23. 23. 48·23	3. 37. 57·77	67. 46. 54·0	61. 3·4	16. 39·9	20. 43. 26·25	19. 52. 42·8	15·9

November 15, 16, and 22. The aperture was reduced.

Day.	Observer.	Object.	Altazimuth-Clock Time of Vertical Transit over Mean of Horizontal Wires.	Lamp Right or Left.	Reading of Vertical Circle corrected for Runs of Micrometers.	Level Indication (additive).	Barometer and External Thermometer.	Refraction.	True observed Zenith Distance.
1874.			h m s.		° ′ ″	″		″	° ′ ″
November 22	NI	Moon's L. L. ...	5. 8. 38·44	R	248. 18. 58·5	58·6		22·4	21. 40. 47·7
		,, ...	5. 17. 57·22	L	293. 44. 56·9	82·0		24·8	23. 46. 21·3
		,, ...	5. 27. 39·84	L	295. 55. 41·8	82·8	30in·14	27·4	25. 57. 9·6
		,, ...	5. 38. 13·34	L	298. 17. 43·0	83·2	64°·2	30·3	28. 19. 14·1
23	NI	Moon's U. L. ...	4. 3. 47·30	R	260. 18. 10·7	66·6	63°·2	9·6	9. 41. 14·7
		,, ...	4. 14. 5·58	R	262. 11. 27·8	65·4		7·7	7. 47. 56·9
		,, ...	4. 24. 24·42	L	276. 11. 2·5	78·4		6·2	6. 12. 4·7
		Moon's L. L. ...	5. 54. 4·08	L	286. 46. 45·6	77·4	63°·3	17·0	16. 47. 57·6
		,, ...	6. 2. 28·50	L	288. 34. 28·4	77·5		19·0	18. 35. 42·5
		,, ...	6. 11. 36·34	L	290. 32. 11·8	78·3		21·2	20. 33. 28·9
		,, ...	6. 19. 24·64	R	247. 45. 4·3	67·0		23·1	22. 14. 34·2
		,, ...	6. 27. 37·00	R	245. 58. 36·1	66·2	63°·3	25·1	24. 1. 5·2
		Aldebaran......	6. 37. 1·68	R	239. 13. 37·8	68·0	30in·15	33·6	30. 46. 10·2
		,, ...	6. 46. 29·72	L	302. 56. 49·0	72·8	63°·0	36·6	32. 58. 16·0
26	NI	Moon's L. L. ...	4. 44. 25·52	L	314. 6. 58·7	77·3	64°·2	54·5	44. 8. 49·1
		,, ...	4. 52. 18·80	L	312. 24. 13·6	77·8		51·3	42. 26. 1·3
		,, ...	5. 1. 6·54	L	310. 29. 27·8	78·6		48·0	40. 31. 13·0
		,, ...	5. 9. 50·06	R	231. 22. 46·2	66·3		44·8	38. 37. 13·7
		,, ...	5. 17. 16·96	R	233. 0. 9·0	65·8	30in·01	42·2	36. 59. 48·8

November 22 and 23. The adopted Zenith point corresponding to the mean wire is 270. 0. 22·4 (° ′ ″)
November 26. ,, ,, ,, 270. 0. 21·4

Greenwich Mean Solar Time, assuming the West Longitude to be I. $10^h. 31^m. 0^s.$ II. $10^h. 32^m. 0^s.$	Tabular Geocentric Elements (R. A. and N. P. D. corrected). Apparent Right Ascension of Center.	Apparent North Polar Distance of Center.	Equatorial Horizontal Parallax.	Semi-diameter.	Hour-Angle.	Tabular Zenith Distance of Star or of Limb of Moon.	Inferred Longitude West of Greenwich $10^h. 31^m.$ +
h m s	h m s	° ′ ″	′ ″	′ ″	° ′ ″	° ′ ″	s
I. 23. 30. 45·16	3. 38. 15·78	67. 45. 33·6	61. 3·3	16. 39·9	22. 38. 27·75	21. 40. 54·0	
II. 23. 31. 45·00	3. 38. 18·35	67. 45. 22·0	61. 3·3	16. 39·9	22. 37. 49·20	21. 40. 18·5	10·7
I. 23. 40. 2·42	3. 38. 39·85	67. 43. 46·4	61. 3·2	16. 39·9	24. 52. 8·40	23. 46. 32·2	
II. 23. 41. 2·26	3. 38. 42·45	67. 43. 34·8	61. 3·2	16. 39·9	24. 51. 29·40	23. 45. 56·0	18·1
I. 23. 49. 43·46	3. 39. 4·97	67. 41. 54·8	61. 3·1	16. 39·8	27. 11. 31·05	25. 57. 23·7	
II. 23. 50. 43·29	3. 39. 7·55	67. 41. 43·3	61. 3·1	16. 39·8	27. 10. 52·35	25. 56. 46·9	22·9
I. 0. 0. 15·24	3. 39. 32·20	67. 39. 53·4	61. 3·0	16. 39·8	29. 43. 5·25	28. 19. 31·0	
II. 0. 1. 15·07	3. 39. 34·79	67. 39. 41·9	61. 3·0	16. 39·8	29. 42. 26·40	28. 18. 54·3	27·6
I. 22. 22. 9·77	4. 38. 58·20	64. 6. 16·6	60. 41·3	16. 33·9	8. 44. 40·20	9. 40. 53·3	
II. 22. 23. 9·61	4. 39. 0·89	64. 6. 9·1	60. 41·3	16. 33·9	8. 45. 20·55	9. 41. 28·5	36·5
I. 22. 32. 26·36	4. 39. 26·06	64. 4. 59·8	60. 41·0	16. 33·8	6. 17. 3·90	7. 47. 36·0	
II. 22. 33. 26·19	4. 39. 28·76	64. 4. 52·4	60. 41·0	16. 33·8	6. 17. 44·40	7. 48. 11·7	35·1
I. 22. 42. 43·52	4. 39. 53·95	64. 3. 43·2	60. 40·8	16. 33·8	3. 49. 19·50	6. 11. 53·9	
II. 22. 43. 43·36	4. 39. 56·65	64. 3. 35·8	60. 40·8	16. 33·8	3. 50. 0·00	6. 12. 21·5	23·5
I. 0. 12. 8·52	4. 43. 56·57	63. 52. 52·0	60. 38·8	16. 33·2	17. 34. 56·70	16. 48. 15·5	
II. 0. 13. 8·36	4. 43. 59·29	63. 52. 44·9	60. 38·8	16. 33·2	17. 34. 15·90	16. 47. 40·9	31·0
I. 0. 20. 31·57	4. 44. 19·36	63. 51. 52·3	60. 38·6	16. 33·2	19. 35. 21·15	18. 36. 1·6	
II. 0. 21. 31·41	4. 44. 22·06	63. 51. 45·2	60. 38·6	16. 33·2	19. 34. 40·65	18. 35. 27·2	33·3
I. 0. 29. 37·93	4. 44. 44·11	63. 50. 47·8	60. 38·4	16. 33·1	21. 46. 7·65	20. 33. 46·6	
II. 0. 30. 37·77	4. 44. 46·81	63. 50. 40·6	60. 38·4	16. 33·1	21. 45. 27·15	20. 33. 11·6	30·3
I. 0. 37. 24·95	4. 45. 5·26	63. 49. 52·8	60. 38·3	16. 33·1	23. 37. 54·90	22. 14. 49·0	
II. 0. 38. 24·78	4. 45. 7·97	63. 49. 45·8	60. 38·3	16. 33·1	23. 37. 14·25	22. 14. 14·0	25·4
I. 0. 45. 35·98	4. 45. 27·52	63. 48. 55·2	60. 38·1	16. 33·0	25. 35. 26·55	24. 1. 20·7	
II. 0. 46. 35·81	4. 45. 30·23	63. 48. 48·3	60. 38·1	16. 33·0	25. 34. 45·90	24. 0. 45·2	26·2
——	4. 28. 45·38	73. 44. 29·4	—	—	32. 7. 8·85	30. 46. 9·6	—
——	,,	,,	—	—	34. 29. 9·60	32. 58. 14·7	—
I. 22. 50. 58·24	7. 53. 17·02	63. 49. 9·8	58. 14·2	15. 53·7	47. 8. 39·30	44. 8. 34·4	
II. 22. 51. 58·08	7. 53. 19·51	63. 49. 16·3	58. 14·2	15. 53·7	47. 9. 16·65	44. 9. 8·3	26·0
I. 22. 58. 50·23	7. 53. 36·67	63. 50. 0·7	58. 13·9	15. 53·6	45. 15. 14·70	42. 25. 46·2	
II. 22. 59. 50·07	7. 53. 39·16	63. 50. 7·1	58. 13·9	15. 53·6	45. 15. 52·05	42. 26. 20·0	26·8
I. 23. 7. 36·54	7. 53. 58·56	63. 50. 57·6	58. 13·5	15. 53·5	43. 8. 46·95	40. 30. 58·7	
II. 23. 8. 36·37	7. 54. 1·04	63. 51. 4·0	58. 13·5	15. 53·5	43. 9. 24·15	40. 31. 32·3	25·5
I. 23. 16. 18·62	7. 54. 20·26	63. 51. 54·2	58. 13·2	15. 53·4	41. 3. 19·65	38. 36. 57·9	
II. 23. 17. 18·46	7. 54. 22·75	63. 52. 0·7	58. 13·2	15. 53·4	41. 3. 57·00	38. 37. 31·7	28·0
I. 23. 23. 44·32	7. 54. 38·77	63. 52. 42·7	58. 12·9	15. 53·3	39. 16. 13·65	36. 59. 32·5	
II. 23. 24. 44·15	7. 54. 41·26	63. 52. 49·2	58. 12·9	15. 53·3	39. 16. 51·00	37. 0. 6·2	29·0

November 23. Moon's limb indistinct. Aperture reduced.

Day.	Observer.	Object.	Altazimuth-Clock Time of Vertical Transit over Mean of Horizontal Wires.	Lamp Right or Left.	Reading of Vertical Circle corrected for Runs of Micrometers.	Level Indication (additive).	Barometer and External Thermometer.	Refraction.	True observed Zenith Distance.
1874.			h m s		° ' "	"		"	° ' "
November 26	NI	Moon's L. L. ...	5. 23. 57·86	R	234. 27. 37·4	65·7	65°·1	40·0	35. 32. 18·3
27	NI	Moon's L. L. ...	4. 54. 2·42	L	325. 27. 38·8	75·3	62°·0	81·8	55. 29. 54·5
		,, ...	5. 1. 51·28	L	323. 44. 46·5	75·1		76·8	53. 46. 57·0
		,, ...	5. 8. 39·58	L	322. 14. 58·5	75·2		72·8	52. 17. 5·1
		,, ...	5. 16. 11·38	L	320. 35. 25·7	75·0		68·6	50. 37. 27·9
		,, ...	5. 24. 43·96	R	221. 16. 2·1	70·0		64·2	48. 44. 13·5
		,, ...	5. 31. 6·56	R	222. 40. 42·5	69·8		61·1	47. 19. 30·2
		,, ...	5. 39. 30·66	R	224. 32. 23·5	69·8		57·3	45. 27. 45·4
		,, ...	5. 46. 51·48	R	226. 10. 15·3	69·7		54·1	43. 49. 50·5
		,, ...	5. 54. 32·68	R	227. 52. 48·7	69·8		51·0	42. 7. 13·9
		,, ...	6. 2. 9·16	R	229. 34. 28·8	69·4		48·2	40. 25. 31·4
		,, ...	6. 9. 45·78	L	308. 41. 57·3	72·6		45·2	38. 43. 33·7
		,, ...	6. 17. 32·86	L	306. 57. 38·3	73·6	60°·8	42·5	36. 59. 13·0
		γ Leonis	6. 35. 28·10	R	219. 30. 24·9	69·9	30in·06	68·4	50. 29. 55·0
		,, ...	6. 44. 28·70	L	318. 23. 41·7	74·2	61°·3	63·6	48. 25. 38·1
28	NI	Moon's L. L. ...	4. 29. 9·60	R	196. 6. 30·0	67·4	69°·9	190·8	73. 55. 54·8
		,, ...	4. 39. 51·80	R	198. 26. 36·6	67·5		165·9	71. 35. 23·2
		,, ...	4. 48. 54·38	R	200. 25. 25·1	67·3		149·0	69. 36. 18·0
		,, ...	4. 58. 13·38	L	337. 30. 1·4	71·4		134·4	67. 33. 5·8

November 27 and 28. The adopted Zenith point corresponding to the mean wire is 270° 0' 21"·4

Greenwich Mean Solar Time, assuming the West Longitude to be I. 10h. 31m. 0s. II. 10h. 32m. 0s.	Tabular Geocentric Elements (R. A. and N. P. D. corrected).				Hour-Angle.	Tabular Zenith Distance of Star or of Limb of Moon.	Inferred Longitude West of Greenwich 10h. 31m. +
	Apparent Right Ascension of Center.	Apparent North Polar Distance of Center.	Equatorial Horizontal Parallax.	Semi-diameter.			
h m s	h m s	° ′ ″	′ ″	′ ″	° ′ ″	° ′ ″	s
I. 23. 30. 24·12	7. 54. 55·38	63. 53. 26·3	58. 12·6	15. 53·2	37. 40. 9·30	35. 32. 5·4	
II. 23. 31. 23·96	7. 54. 57·86	63. 53. 32·8	58. 12·6	15. 53·2	37. 40. 46·50	35. 32. 38·7	23·2
I. 22. 56. 39·00	8. 50. 57·57	67. 4. 42·6	57. 16·8	15. 38·1	59. 9. 13·65	55. 29. 37·5	
II. 22. 57. 38·84	8. 50. 59·86	67. 4. 52·2	57. 16·8	15. 38·1	59. 9. 48·00	55. 30. 10·3	31·1
I. 23. 4. 26·59	8. 51. 15·41	67. 5. 57·5	57. 16·5	15. 38·0	57. 16. 28·20	53. 46. 39·2	
II. 23. 5. 26·43	8. 51. 17·69	67. 6. 7·1	57. 16·5	15. 38·0	57. 17. 2·40	53. 47. 11·9	32·7
I. 23. 11. 13·78	8. 51. 30·93	67. 7. 2·9	57. 16·2	15. 37·9	55. 38. 16·50	52. 16. 48·3	
II. 23. 12. 13·62	8. 51. 33·21	67. 7. 12·5	57. 16·2	15. 37·9	55. 38. 50·70	52. 17. 20·9	30·9
I. 23. 18. 44·35	8. 51. 48·09	67. 8. 15·2	57. 15·9	15. 37·8	53. 49. 36·90	50. 37. 10·5	
II. 23. 19. 44·19	8. 51. 50·37	67. 8. 24·9	57. 15·9	15. 37·8	53. 50. 11·10	50. 37. 43·1	32·0
I. 23. 27. 15·54	8. 52. 7·57	67. 9. 37·5	57. 15·6	15. 37·8	51. 46. 20·25	48. 43. 55·4	
II. 23. 28. 15·37	8. 52. 9·84	67. 9. 47·1	57. 15·6	15. 37·8	51. 46. 54·30	48. 44. 27·9	33·4
I. 23. 33. 37·09	8. 52. 22·09	67. 10. 39·0	57. 15·3	15. 37·7	50. 14. 19·05	47. 19. 13·7	
II. 23. 34. 36·93	8. 52. 24·36	67. 10. 48·6	57. 15·3	15. 37·7	50. 14. 53·10	47. 19. 46·3	30·4
I. 23. 41. 59·83	8. 52. 41·22	67. 12. 0·1	57. 15·0	15. 37·6	48. 13. 4·35	45. 27. 27·1	
II. 23. 42. 59·67	8. 52. 43·49	67. 12. 9·8	57. 15·0	15. 37·6	48. 13. 38·40	45. 27. 59·4	34·0
I. 23. 49. 19·44	8. 52. 57·93	67. 13. 11·1	57. 14·7	15. 37·5	46. 27. 2·70	43. 49. 31·7	
II. 23. 50. 19·28	8. 53. 0·21	67. 13. 20·8	57. 14·7	15. 37·5	46. 27. 36·90	43. 50. 4·2	34·7
I. 23. 56. 59·38	8. 53. 15·42	67. 14. 25·6	57. 14·4	15. 37·4	44. 36. 7·05	42. 6. 55·2	
II. 23. 57. 59·22	8. 53. 17·69	67. 14. 35·2	57. 14·4	15. 37·4	44. 36. 41·10	42. 7. 27·4	34·8
I. 0. 4. 34·62	8. 53. 32·82	67. 15. 38·7	57. 14·1	15. 37·4	42. 46. 20·70	40. 25. 13·5	
II. 0. 5. 34·46	8. 53. 35·10	67. 15. 48·4	57. 14·1	15. 37·4	42. 46. 54·90	40. 25. 45·8	33·2
I. 0. 12. 10·00	8. 53. 50·12	67. 16. 52·6	57. 13·8	15. 37·3	40. 56. 30·90	38. 43. 19·4	
II. 0. 13. 9·84	8. 53. 52·39	67. 17. 2·3	57. 13·8	15. 37·3	40. 57. 4·95	38. 43. 51·7	26·6
I. 0. 19. 55·81	8. 54. 7·80	67. 18. 8·3	57. 13·5	15. 37·2	39. 4. 9·90	36. 58. 56·4	
II. 0. 20. 55·64	8. 54. 10·07	67. 18. 18·0	57. 13·5	15. 37·2	39. 4. 43·95	36. 59. 28·5	31·0
——	10. 13. 4·17	69. 31. 33·4	—	—	54. 19. 26·70	50. 29. 55·3	—
——	,,	,,	—	—	52. 4. 17·55	48. 25. 38·2	—
I. 22. 27. 55·59	9. 42. 28·62	71. 17. 19·3	56. 24·2	15. 23·7	78. 14. 53·10	73. 55. 36·0	
II. 22. 28. 55·43	9. 42. 30·71	71. 17. 31·0	56. 24·2	15. 23·7	78. 15. 24·45	73. 56. 7·4	35·9
I. 22. 38. 36·05	9. 42. 50·97	71. 19. 24·6	56. 23·8	15. 23·6	75. 39. 55·20	71. 35. 6·1	
II. 22. 39. 35·88	9. 42. 53·06	71. 19. 36·3	56. 23·8	15. 23·6	75. 40. 26·55	71. 35. 37·9	32·3
I. 22. 47. 37·14	9. 43. 9·86	71. 21. 10·5	56. 23·5	15. 23·5	73. 28. 59·85	69. 35. 58·4	
II. 22. 48. 36·98	9. 43. 11·95	71. 21. 22·3	56. 23·5	15. 23·5	73. 29. 31·20	69. 36. 30·0	37·2
I. 22. 56. 54·63	9. 43. 29·31	71. 22. 59·8	56. 23·2	15. 23·4	71. 14. 6·45	67. 32. 50·5	
II. 22. 57. 54·47	9. 43. 31·39	71. 23. 11·5	56. 23·2	15. 23·4	71. 14. 37·65	67. 33. 22·0	29·1

Day.	Observer.	Object.	Altazimuth-Clock Time of Vertical Transit over Mean of Horizontal Wires.	Lamp Right or Left.	Reading of Vertical Circle corrected for Runs of Micrometers.	Level Indication (additive).	Barometer and External Thermometer.	Refraction.	True observed Zenith Distance.
			h m s		° ′ ″	″		″	° ′ ″
1874. November 28	NI	Moon's L. L. ...	5. 9. 5·34	L	335. 6. 5·9	73·0	30in·23	120·1	65. 8. 57·6
		,, ...	5. 21. 54·56	L	332. 15. 42·5	73·0	68°·8	106·1	62. 18. 20·2
		β Ursæ Majoris .	5. 38. 12·70	L	336. 14. 29·1	79·3		126·6	66. 17. 33·6
		,, .	5. 48. 37·66	R	205. 8. 33·8	63·8	69°·1	118·6	64. 52. 42·4
29	NI	Regulus........	6. 59. 32·40	R	225. 48. 28·5	70·4		54·3	44. 11. 38·6
		,, ...	7. 14. 42·64	L	310. 38. 39·5	71·3		48·0	40. 40. 15·6
		,, ...	7. 23. 24·08	R	231. 20. 27·2	72·6	71°·1	44·7	38. 39. 28·1
		,, ...	7. 34. 49·04	L	305. 59. 45·7	69·4		40·6	36. 1. 12·5
		Moon's L. L. ...	7. 45. 48·72	L	312. 20. 56·5	70·5		51·0	42. 22. 34·8
		,, ...	7. 55. 6·40	L	310. 14. 47·6	70·6		47·3	40. 16. 22·3
		,, ...	8. 2. 14·58	L	308. 38. 3·7	70·6		44·7	38. 39. 35·8
		,, ...	8. 9. 55·92	R	233. 4. 19·9	71·2		42·0	36. 55. 34·1
		,, ...	8. 17. 36·54	R	234. 48. 2·8	70·4	30in·24	39·4	35. 11. 49·4
		,, ...	8. 25. 21·14	R	236. 32. 21·3	70·1	71°·0	36·9	33. 27. 28·7
December 1	NI	Moon's L. L. ...	7. 29. 36·50	R	199. 45. 13·0	69·0	70°·5	154·1	70. 16. 34·5
		,, ...	7. 40. 6·30	R	202. 6. 15·3	69·3		136·7	67. 55. 14·5
		,, ...	7. 50. 42·14	R	204. 28. 24·8	69·4		122·2	65. 32. 50·4
		,, ...	7. 59. 46·98	L	333. 28. 18·7	72·4		111·7	63. 31. 0·4
		,, ...	8. 8. 23·34	L	331. 33. 21·7	73·0		103·1	61. 35. 55·4
		,, ...	8. 15. 50·52	L	329. 54. 2·2	73·1	69°·4	96·4	59. 56. 29·3
		Mars (as a star).	8. 30. 52·62	L	343. 7. 21·1	73·2	69°·3	182·5	73. 11. 14·4
		,, .	8. 39. 52·12	L	341. 6. 1·6	72·2		162·0	71. 9. 33·4

November 29. The adopted Zenith point corresponding to the mean wire is 270. 0. 23·2 (° ′ ″)
December 1. ,, ,, ,, 270. 0. 22·4

Greenwich Mean Solar Time, assuming the West Longitude to be I. 10h. 31m. 0s. II. 10h. 32m. 0s.	Tabular Geocentric Elements (R. A. and N. P. D. corrected).				Hour-Angle.	Tabular Zenith Distance of Star or of Limb of Moon.	Inferred Longitude West of Greenwich 10h. 31m. +
	Apparent Right Ascension of Center.	Apparent North Polar Distance of Center.	Equatorial Horizontal Parallax.	Semi-diameter.			
h m s	h m s	° ′ ″	′ ″	′ ″	° ′ ″	° ′ ″	s
I. 23. 7.44·82	9.43.51·98	71.25. 7·3	56.22·8	15.23·3	68.36.46·95	65. 8.45·0	
II. 23. 8.44·65	9.43.54·09	71.25.19·1	56.22·8	15.23·3	68.37.18·60	65. 9.17·0	23·6
I. 23.20.31·95	9.44.18·69	71.27.38·0	56.22·4	15.23·2	65.31. 9·15	62.18. 7·1	
II. 23.21.31·78	9.44.20·78	71.27.49·7	56.22·4	15.23·2	65.31.40·50	62.18.38·9	24·7
—	10.54.16·92	32.57. 0·6	—	—	78.56.10·20	66.17.35·5	—
—	,,	,,	—	—	76.19.55·65	64.52.39·7	—
—	10. 1.42·34	77.25.14·7	—	—	45.27.12·60	44.11.35·0	—
—	,,	,,	—	—	41.39.38·70	40.40.15·2	—
—	,,	,,		—	39.29.16·95	38.39.27·4	—
—	,,	,,	—	—	36.38. 2·40	36. 1.10·7	—
I. 1.40. 8·28	10.36.57·12	76.58.42·6	55.31·9	15. 9·4	42.41.48·60	42.22.23·5	
II. 1.41. 8·09	10.36.59·03	76.58.55·6	55.31·9	15. 9·4	42.42.17·25	42.22.54·2	22·1
I. 1.49.24·42	10.37.14·90	77. 0.45·2	55.31·6	15. 9·3	40.26.49·95	40.16.10·7	
II. 1.50.24·26	10.37.16·80	77. 0.58·3	55.31·6	15. 9·3	40.27.18·45	40.16.41·0	23·0
I. 1.56.31·44	10.37.28·55	77. 2.19·3	55.31·4	15. 9·3	38.43.11·85	38.39.23·8	
II. 1.57.31·28	10.37.30·46	77. 2.32·5	55.31·4	15. 9·3	38.43.40·50	38.39.54·5	23·4
I. 2. 4.11·52	10.37.43·25	77. 4. 0·8	55.31·2	15. 9·2	36.51.32·25	36.55.17·5	
II. 2. 5.11·36	10.37.45·16	77. 4.14·0	55.31·2	15. 9·2	36.52. 0·90	36.55.48·4	32·2
I. 2.11.50·90	10.37.57·91	77. 5.42·1	55.31·0	15. 9·2	35. 0. 2·70	35.11.34·1	
II. 2.12.50·73	10.37.59·83	77. 5.55·3	55.31·0	15. 9·2	35. 0.31·50	35.12. 4·8	29·9
I. 2.19.34·25	10.38.12·70	77. 7.24·4	55.30·8	15. 9·1	33. 7.35·40	33.27.12·9	
II. 2.20.34·08	10.38.14·63	77. 7.37·6	55.30·8	15. 9·1	33. 8. 4·35	33.27.44·2	30·3
I. 1.16. 9·81	12. 3.40·77	87.55.54·2	54.28·6	14.52·2	68.25. 2·40	70.16.17·6	
II. 1.17. 9·64	12. 3.42·52	87.56. 8·2	54.28·6	14.52·2	68.25.28·65	70.16.47·0	34·5
I. 1.26.37·89	12. 3.59·16	87.58.21·6	54.28·5	14.52·1	65.52.11·25	67.54.58·3	
II. 1.27.37·72	12. 4. 0·92	87.58.35·7	54.28·5	14.52·1	65.52.37·65	67.55.28·1	32·6
I. 1.37.12·00	12. 4.17·74	88. 0.50·5	54.28·3	14.52·1	63.17.52·20	65.32.34·4	
II. 1.38.11·83	12. 4.19·48	88. 1. 4·5	54.28·3	14.52·1	63.18.18·30	65.33. 3·9	32·5
I. 1.46.15·36	12. 4.33·64	88. 2.58·0	54.28·2	14.52·1	61. 5.37·95	63.30.49·4	
II. 1.47.15·20	12. 4.35·39	88. 3.12·1	54.28·2	14.52·1	61. 6. 4·20	63.31.19·1	22·2
I. 1.54.50·31	12. 4.48·71	88. 4.58·9	54.28·1	14.52·0	59. 0.18·60	61.35.43·4	
II. 1.55.50·15	12. 4.50·47	88. 5.13·0	54.28·1	14.52·0	59. 0.45·00	61.36.13·3	24·1
I. 2. 2.16·28	12. 5. 1·77	88. 6.43·6	54.27·9	14.52·0	57.11.46·65	59.56.18·2	
II. 2. 3.16·12	12. 5. 3·52	88. 6.57·6	54.27·9	14.52·0	57.12.12·90	59.56.47·9	22·4
2.17.42·84	13. 8.41·20	95.55.57·1	0. 4·3	—	69.21. 6·45	73.11.19·1	—
2.26.40·87	13. 8.42·05	95.56. 2·4	0. 4·3	—	67. 6.26·70	71. 9.37·1	—

Day.	Observer.	Object.	Altazimuth-Clock Time of Vertical Transit over Mean of Horizontal Wires.	Lamp Right or Left.	Reading of Vertical Circle corrected for Runs of Micrometers.	Level Indication (additive).	Barometer and External Thermometer.	Refraction.	True observed Zenith Distance.
1874.			h m s		° ′ ″	″		″	° ′ ″
December 1	NI	Mars (as a star).	8. 47. 56·04	R	200. 40. 47·7	69·2	30in·22	146·8	69. 20. 52·3
		,, .	8. 55. 20·26	R	202. 19. 57·3	69·1	71°·0	134·9	67. 41. 30·9
2	NI	Moon's L. L. ...	8. 43. 3·10	R	204. 9. 34·8	67·6	70°·9	123·7	65. 51. 41·7
		,, ...	8. 53. 24·24	R	206. 24. 22·9	67·4		111·9	63. 36. 42·0
		,, ...	9. 2. 23·12	R	208. 20. 38·8	67·0		103·1	61. 40. 17·7
		,, ...	9. 12. 58·04	L	329. 21. 35·0	73·4		94·1	59. 24. 2·1
		,, ...	9. 22. 30·76	L	327. 19. 48·1	73·6	30in·23	86·9	57. 22. 8·2
		,, ...	9. 32. 13·36	L	325. 16. 59·3	74·4	70°·5	80·5	55. 19. 13·8
		Mars (as a star).	9. 54. 18·52	R	214. 35. 24·7	67·2		80·8	55. 25. 9·3
		,, .	10. 3. 56·12	L	323. 21. 15·8	72·9		75·0	53. 23. 23·3
4	NI	Mars (as a star).	9. 43. 5·52	R	211. 0. 9·7	67·4		93·0	59. 0. 36·3
		,, .	9. 55. 32·52	L	326. 18. 43·4	73·4	67°·1	84·0	56. 21. 0·4
		Moon's L. L. ...	10. 6. 49·88	L	341. 47. 34·3	74·8		168·8	71. 51. 17·5
		,, ...	10. 15. 10·60	L	340. 6. 12·0	74·8		153·7	70. 9. 40·1
		,, ...	10. 24. 27·68	L	338. 14. 25·2	74·2	30in·12	139·6	68. 17. 38·6
		,, ...	10. 33. 35·22	R	203. 32. 32·9	69·4	67°·3	127·8	66. 28. 45·9
14	NI	Moon's L. L. ...	1. 9. 22·14	L	320. 38. 3·6	55·5	72°·0	67·8	50. 39. 46·5
		,, ...	1. 17. 22·12	L	322. 2. 10·3	55·6		71·3	52. 3. 56·8
		,, ...	1. 25. 47·52	L	323. 32. 43·0	55·8		75·3	53. 34. 33·7
		,, ...	1. 53. 3·22	R	211. 20. 11·3	87·3		91·2	58. 40. 13·0
		,, ...	2. 3. 49·24	R	209. 15. 12·2	86·1		99·0	60 45. 21·1

December 2 to December 14, 270. 0. 20·4. The observations of *Mars* have been used only for Zenith point.

Greenwich Mean Solar Time, assuming the West Longitude to be I. 10h. 31m. 0s. II. 10h. 32m. 0s.	Tabular Geocentric Elements (R. A. and N. P. D. corrected). Apparent Right Ascension of Center.	Apparent North Polar Distance of Center.	Equatorial Horizontal Parallax.	Semi-diameter.	Hour-Angle.	Tabular Zenith Distance of Star or of Limb of Moon.	Inferred Longitude West of Greenwich 10h. 31m. +
h m s	h m s	° ′ ″	′ ″	′ ″	° ′ ″	° ′ ″	s
2. 34. 43·48	13. 8. 42·80	95. 56. 7·0	0. 4·3	—	65. 5. 39·00	69. 20. 54·9	—
2. 42. 6·48	13. 8. 43·65	95. 56. 12·2	0. 4·3	—	63. 14. 48·45	67. 41. 35·8	—
I. 2. 25. 30·05	12. 47. 39·00	93. 48. 28·9	54. 10·7	14. 47·3	61. 2. 33·00	65. 51. 27·9	
II. 2. 26. 29·88	12. 47. 40·75	93. 48. 42·7	54. 10·7	14. 47·3	61. 2. 59·25	65. 51. 57·7	27·8
I. 2. 35. 49·50	12. 47. 57·03	93. 50. 52·1	54. 10·6	14. 47·2	58. 31. 46·20	63. 36. 27·4	
II. 2. 36. 49·33	12. 47. 58·77	93. 51. 5·9	54. 10·6	14. 47·2	58. 32. 12·30	63. 36. 56·8	29·8
I. 2. 44. 46·92	12. 48. 12·68	93. 52. 56·4	54. 10·6	14. 47·2	56. 20. 57·60	61. 40. 1·7	
II. 2. 45. 46·76	12. 48. 14·42	93. 53. 10·2	54. 10·6	14. 47·2	56. 21. 23·70	61. 40. 31·1	32·6
I. 2. 55. 20·10	12. 48. 31·12	93. 55. 22·7	54. 10·5	14. 47·2	53. 46. 50·40	59. 23. 47·5	
II. 2. 56. 19·94	12. 48. 32·86	93. 55. 36·5	54. 10·5	14. 47·2	53. 47. 16·50	59. 24. 17·0	29·7
I. 3. 4. 51·28	12. 48. 47·75	93. 57. 34·7	54. 10·4	14. 47·2	51. 27. 48·90	57. 21. 53·8	
II. 3. 5. 51·11	12. 48. 49·49	93. 57. 48·5	54. 10·4	14. 47·2	51. 28. 15·00	57. 22. 23·2	29·4
I. 3. 14. 32·29	12. 49. 4·67	93. 59. 49·0	54. 10·3	14. 47·1	49. 6. 23·55	55. 19. 0·1	
II. 3. 15. 32·12	12. 49. 6·41	94. 0. 2·8	54. 10·3	14. 47·1	49. 6. 49·65	55. 19. 29·2	28·2
3. 37. 0·76	13. 11. 4·64	96. 10. 40·8	0. 4·3	—	49. 5. 5·55	55. 25. 11·8	—
3. 46. 36·80	13. 11. 5·54	96. 10. 46·3	0. 4·3	—	46. 40. 54·90	53. 23. 26·2	—
3. 17. 59·97	13. 15. 34·83	96. 38. 15·4	0. 4·3	—	53. 0. 20·40	59. 0. 39·0	—
3. 30. 24·92	13. 15. 36·00	96. 38. 22·5	0. 4·3	—	49. 53. 52·95	56. 21. 1·2	—
I. 3. 41. 13·53	14. 15. 47·20	104. 38. 15·9	54. 3·9	14. 45·4	62. 7. 20·40	71. 51. 0·2	
II. 3. 42. 13·37	14. 15. 49·04	104. 38. 28·1	54. 3·9	14. 45·4	62. 7. 48·00	71. 51. 29·5	35·4
I. 3. 49. 32·88	14. 16. 2·67	104. 39. 57·5	54. 4·0	14. 45·4	60. 6. 1·65	70. 9. 22·4	
II. 3. 50. 32·72	14. 16. 4·52	104. 40. 9·6	54. 4·0	14. 45·4	60. 6. 29·40	70. 9. 51·7	36·2
I. 3. 58. 48·46	14. 16. 19·89	104. 41. 50·4	54. 4·0	14. 45·4	57. 51. 3·60	68. 17. 23·1	
II. 3. 59. 48·30	14. 16. 21·75	104. 42. 2·5	54. 4·0	14. 45·4	57. 51. 31·50	68. 17. 52·5	31·6
I. 4. 7. 54·50	14. 16. 36·82	104. 43. 41·3	54. 4·0	14. 45·4	55. 38. 24·45	66. 28. 32·0	
II. 4. 8. 54·34	14. 16. 38·68	104. 43. 53·4	54. 4·0	14. 45·4	55. 38. 52·35	66. 29. 1·3	28·4
I. 18. 6. 2·43	22. 41. 18·12	102. 22. 32·5	57. 53·8	15. 48·1	37. 9. 55·80	50. 39. 55·8	
II. 18. 7. 2·26	22. 41. 20·20	102. 22. 18·0	57. 53·8	15. 48·1	37. 9. 24·60	50. 39. 23·4	17·2
I. 18. 14. 1·11	22. 41. 34·73	102. 20. 36·4	57. 54·0	15. 48·2	39. 5. 46·50	52. 4. 4·9	
II. 18. 15. 0·94	22. 41. 36·80	102. 20. 21·9	57. 54·0	15. 48·2	39. 5. 15·45	52. 3. 32·5	15·0
I. 18. 22. 25·14	22. 41. 52·20	102. 18. 34·1	57. 54·2	15. 48·2	41. 7. 45·60	53. 34. 44·2	
II. 18. 23. 24·98	22. 41. 54·27	102. 18. 19·6	57. 54·2	15. 48·2	41. 7. 14·55	53. 34. 11·5	19·3
I. 18. 49. 36·40	22. 42. 48·74	102. 11. 57·8	57. 54·9	15. 48·4	47. 42. 33·30	58. 40. 26·5	
II. 18. 50. 36·23	22. 42. 50·83	102. 11. 43·2	57. 54·9	15. 48·4	47. 42. 1·95	58. 39. 53·0	24·2
I. 19. 0. 25·66	22. 43. 11·24	102. 9. 19·8	57. 55·1	15. 48·5	50. 18. 26·25	60. 45. 31·8	
II. 19. 1. 25·49	22. 43. 13·33	102. 9. 5·2	57. 55·1	15. 48·5	50. 17. 54·90	60. 44. 58·2	19·1

December 14. The aperture was slightly reduced.

Day.	Observer.	Object.	Altazimuth-Clock Time of Vertical Transit over Mean of Horizontal Wires.	Lamp Right or Left.	Reading of Vertical Circle corrected for Runs of Micrometers.	Level Indication (additive).	Barometer and External Thermometer.	Refraction.	True observed Zenith Distance.
			h m s		° ′ ″	″		″	° ′ ″
1874. December 14	NI	Moon's L. L. ...	2. 11. 35·40	R	207. 43. 40·6	85·9		105·5	62. 16. 59·4
		β Ceti	2. 20. 44·12	R	222. 36. 20·2	86·6	30in·20	60·3	47. 23. 34·1
		,, ...	2. 30. 12·20	L	318. 38. 59·2	54·0	71°·9	63·2	48. 40. 36·0
15	NI	Moon's L. L. ...	2. 18. 28·66	L	319. 59. 8·1	59·0	66°·8	66·9	50. 0. 53·6
		,, ...	2. 26. 45·52	L	321. 37. 16·5	59·3		70·9	51. 39. 6·3
		,, ...	2. 44. 36·12	L	325. 13. 1·8	59·8		80·9	55. 15. 2·1
		,, ...	2. 53. 48·48	R	212. 51. 57·4	85·6		86·8	57. 8. 24·2
		,, ...	3. 3. 44·06	R	210. 48. 25·4	83·7		94·0	59. 12. 5·3
		,, ...	3. 14. 43·24	R	208. 30. 16·8	83·4	65°·9	103·2	61. 30. 23·4
		β Ceti	3. 24. 43·54	R	212. 39. 37·7	84·6	30in·20	87·5	57. 20. 45·6
		,, ...	3. 34. 53·02	L	329. 7. 1·3	56·2	66°·5	93·8	59. 9. 10·9
18	NI	Moon's L. L. ...	4. 43. 11·42	L	307. 58. 7·1	60·2		43·6	37. 59. 26·5
		,, ...	4. 50. 24·08	L	309. 35. 35·5	60·6	71°·1	46·2	39. 36. 57·9
		,, ...	5. 11. 19·90	L	314. 18. 46·1	60·9		54·5	44. 20. 17·1
		,, ...	5. 20. 59·84	R	223. 28. 49·9	81·2		58·7	46. 31. 12·0
		,, ...	5. 30. 12·96	R	221. 24. 3·7	80·0	30in·17	63·2	48. 36. 3·9
		,, ...	5. 39. 44·74	R	219. 15. 18·2	79·6	71°·0	68·2	50. 44. 54·8
		α Arietis	6. 7. 24·12	R	212. 59. 53·2	77·0		85·7	57. 0. 39·9
		,, ...	6. 16. 0·68	L	328. 54. 57·5	64·5		92·4	58. 57. 10·0
19	NI	Moon's L. L. ...	5. 24. 15·18	L	302. 38. 6·7	62·4	65°·5	36·0	32. 39. 20·7
		,, ...	5. 32. 7·48	L	304. 24. 42·2	62·0		38·5	34. 25. 58·3

					° ′ ″
December 15.	The adopted Zenith point corresponding to the mean wire is				270. 0. 20·4
December 18.	,,	,,	,,		270. 0. 24·4
December 19.	,,	,,	,,		270. 0. 24·4

Greenwich Mean Solar Time, assuming the West Longitude to be I. 10h. 31m. 0s. II. 10h. 32m. 0s.	Tabular Geocentric Elements (R. A. and N. P. D. corrected). Apparent Right Ascension of Center.	Apparent North Polar Distance of Center.	Equatorial Horizontal Parallax.	Semi-diameter.	Hour-Angle.	Tabular Zenith Distance of Star or of Limb of Moon.	Inferred Longitude West of Greenwich 10h. 31m. +
h m s	h m s	° ′ ″	′ ″	′ ″	° ′ ″	° ′ ″	s
I. 19. 8. 5·56	22. 43. 27·18	102. 7. 27·8	57. 55·3	15. 48·5	52. 10. 59·55	62. 17. 11·2	
II. 19. 9. 5·39	22. 43. 29·27	102. 7. 13·2	57. 55·3	15. 48·5	52. 10. 28·20	62. 16. 37·5	21·0
——	0. 37. 18·82	108. 40. 31·1	—	—	26. 0. 15·90	47. 23. 32·9	—
——	,,	,,	—	—	28. 22. 17·25	48. 40. 34·5	—
I. 19. 11. 2·41	23. 32. 59·88	95. 58. 23·8	58. 31·0	15. 58·3	41. 31. 17·70	50. 1. 6·5	
II. 19. 12. 2·24	23. 33. 1·93	95. 58. 7·9	58. 31·0	15. 58·3	41. 30. 46·95	50. 0. 32·5	22·8
I. 19. 19. 17·93	23. 33. 16·81	95. 56. 11·9	58. 31·2	15. 58·3	43. 31. 16·80	51. 39. 17·3	
II. 19. 20. 17·76	23. 33. 18·85	95. 55. 56·0	58. 31·2	15. 58·3	43. 30. 46·20	51. 38. 43·2	19·4
I. 19. 37. 5·60	23. 33. 53·26	95. 51. 27·6	58. 31·6	15. 58·5	47. 49. 49·05	55. 15. 14·7	
II. 19. 38. 5·44	23. 33. 55·31	95. 51. 11·7	58. 31·6	15. 58·5	47. 49. 18·30	55. 14. 40·5	22·1
I. 19. 46. 16·45	23. 34. 12·08	95. 49. 0·8	58. 31·9	15. 58·5	50. 3. 12·15	57. 8. 41·6	
II. 19. 47. 16·29	23. 34. 14·12	95. 48. 44·9	58. 31·9	15. 58·5	50. 2. 41·55	57. 8. 7·3	30·4
I. 19. 56. 10·42	23. 34. 32·36	95. 46. 22·5	58. 32·1	15. 58·6	52. 27. 1·80	59. 12. 20·9	
II. 19. 57. 10·25	23. 34. 34·40	95. 46. 6·6	58. 32·1	15. 58·6	52. 26. 31·20	59. 11. 46·6	27·3
I. 20. 7. 7·79	23. 34. 54·81	95. 43. 27·2	58. 32·4	15. 58·7	55. 6. 12·75	61. 30. 37·9	
II. 20. 8. 7·63	23. 34. 56·85	95. 43. 11·3	58. 32·4	15. 58·7	55. 5. 42·15	61. 30. 3·6	25·4
——	0. 37. 18·80	108. 40. 31·1	—	—	42. 0. 17·40	57. 20. 44·3	—
——	,,	,,	—	—	44. 32. 39·75	59. 9. 9·1	—
I. 21. 23. 35·75	2. 10. 30·66	75. 50. 43·4	60. 5·1	16. 24·0	38. 19. 47·70	37. 59. 47·4	
II. 21. 24. 35·58	2. 10. 32·93	75. 50. 28·3	60. 5·1	16. 24·0	38. 19. 13·65	37. 59. 11·5	34·9
I. 21. 30. 47·23	2. 10. 47·06	75. 48. 54·3	60. 5·2	16. 24·0	40. 3. 51·60	39. 37. 17·9	
II. 21. 31. 47·06	2. 10. 59·34	75. 48. 39·2	60. 5·2	16. 24·0	40. 3. 17·40	39. 36. 41·9	33·3
I. 21. 51. 39·63	2. 11. 34·68	75. 43. 38·0	60. 5·5	16. 24·1	45. 5. 54·75	44. 20. 37·0	
II. 21. 52. 39·47	2. 11. 36·96	75. 43. 22·9	60. 5·5	16. 24·1	45. 5. 20·55	44. 20. 1·0	33·2
I. 22. 1. 17·99	2. 11. 56·70	75. 41. 12·1	60. 5·6	16. 24·2	47. 25. 23·55	46. 31. 29·0	
II. 22. 2. 17·83	2. 11. 58·98	75. 40. 57·0	60. 5·6	16. 24·2	47. 24. 49·35	46. 30. 52·9	28·2
I. 22. 10. 29·61	2. 12. 17·70	75. 38. 53·1	60. 5·7	16. 24·2	49. 38. 25·50	48. 36. 16·0	
II. 22. 11. 29·44	2. 12. 19·98	75. 38. 38·0	60. 5·7	16. 24·2	49. 37. 51·30	48. 35. 40·1	20·2
I. 22. 19. 59·83	2. 12. 39·41	75. 36. 29·5	60. 5·9	16. 24·2	51. 55. 56·55	50. 45. 11·1	
II. 22. 20. 59·66	2. 12. 41·70	75. 36. 14·4	60. 5·9	16. 24·2	51. 55. 22·20	50. 44. 35·0	27·1
——	2. 0. 7·79	67. 7. 39·0	—	—	61. 58. 42·00	57. 0. 38·3	—
——	,,	,,	—	—	64. 7. 50·10	58. 57. 11·2	—
I. 22. 0. 37·48	3. 8. 40·93	70. 4. 10·7	60. 19·9	16. 28·0	34. 3. 19·35	32. 39. 36·2	
II. 22. 1. 37·32	3. 8. 43·39	70. 3. 58·0	60. 19·9	16. 28·0	34. 2. 42·45	32. 39. 0·1	25·8
I. 22. 8. 28·49	3. 9. 0·15	70. 2. 30·5	60. 19·9	16. 28·0	35. 56. 35·55	34. 26. 11·0	
II. 22. 9. 28·32	3. 9. 2·61	70. 2. 17·8	60. 19·9	16. 28·0	35. 55. 58·65	34. 25. 34·5	20·9

Day.	Observer.	Object.	Altazimuth-Clock Time of Vertical Transit over Mean of Horizontal Wires.	Lamp Right or Left.	Reading of Vertical Circle corrected for Runs of Micrometers.	Level Indication (additive).	Barometer and External Thermometer.	Refraction.	True observed Zenith Distance.
			h m s		° ′ ″	″		″	° ′ ″
1874. December 19	NI	Moon's L. L. ...	5. 38. 40·74	L	305. 53. 16·1	62·4	65°·5	40·7	35. 54. 34·8
		,, ...	5. 51. 34·74	R	231. 10. 59·5	81·0		45·2	38. 48. 49·1
		,, ...	5. 59. 47·44	R	229. 20. 20·9	80·6		48·2	40. 39. 31·1
		,, ...	6. 7. 5·34	R	227. 42. 8·5	79·5		51·1	42. 17. 47·5
		α Tauri	6. 20. 52·08	R	242. 52. 15·1	80·9	30in·09	28·8	27. 7. 17·2
		,, ...	6. 28. 52·74	L	298. 57. 42·7	58·5	66°·1	31·1	28. 58. 47·9
20	NI	Moon's L. L. ...	7. 22. 58·90	L	314. 23. 47·4	64·4	60°·4	55·5	44. 25. 21·9
		,, ...	7. 33. 15·32	L	316. 38. 22·5	64·6		59·9	46. 40. 1·6
		,, ...	7. 43. 31·94	L	318. 52. 46·4	64·6	30in·07	64·8	48. 54. 30·4
		,, ...	7. 57. 11·56	R	218. 7. 40·9	81·6	63°·1	71·8	51. 52. 34·7
		...	8. 36. 59·16	R	209. 33. 6·1	80·2		99·1	60. 27. 38·2
		,, ...	8. 44. 52·40	R	207. 51. 55·8	80·2		106·1	62. 8. 55·5
21	NI	Moon's L. L. ...	7. 52. 17·38	R	233. 56. 41·4	79·8	59°·0	41·3	36. 3. 6·5
		,, ...	7. 59. 46·14	R	232. 20. 15·3	80·4		43·7	37. 39. 34·4
		,, ...	8. 7. 58·96	R	230. 34. 26·6	80·3		46·6	39. 25. 26·1
		,, ...	8. 19. 29·34	L	311. 52. 8·9	63·0		50·7	41. 53. 36·2
		,, ...	8. 26. 53·18	L	313. 27. 16·0	66·6	30in·00	53·6	43. 28. 46·8
		,, ...	8. 34. 20·38	L	315. 3. 2·3	63·5	61°·7	56·6	45. 4. 36·0
		γ Geminorum ...	8. 58. 24·14	L	305. 21. 49·3	58·8		40·1	35. 23. 1·8
		,, ...	9. 6. 54·64	R	232. 37. 48·4	85·8		43·1	37. 21. 54·3
		,, ...	9. 18. 13·90	L	309. 58. 49·3	58·4		47·4	40. 0. 8·7

December 20. The adopted Zenith point corresponding to the mean wire is 270. 0. 25·4 (° ′ ″)
December 21. " " " 270. 0. 26·4

Greenwich Mean Solar Time, assuming the West Longitude to be I. 10ʰ. 31ᵐ. 0ˢ. II. 10ʰ. 32ᵐ. 0ˢ.	Tabular Geocentric Elements (R. A. and N. P. D. corrected). Apparent Right Ascension of Center.	Apparent North Polar Distance of Center.	Equatorial Horizontal Parallax.	Semi-diameter.	Hour-Angle.	Tabular Zenith Distance of Star or of Limb of Moon.	Inferred Longitude West of Greenwich 10ʰ. 31ᵐ. +
h m s	h m s	° ′ ″	′ ″	′ ″	° ′ ″	° ′ ″	s
I. 22. 15. 0·68	3. 9. 16·17	70. 1. 7·2	60. 20·0	16. 28·1	37. 30. 54·30	35. 54. 50·4	
II. 22. 16. 0·52	3. 9. 18·63	70. 0. 54·5	60. 20·0	16. 28·1	37. 30. 17·40	35. 54. 14·1	25·8
I. 22. 27. 52·57	3. 9. 47·74	69. 58. 23·4	60. 20·0	16. 28·1	40. 36. 30·75	38. 49. 3·5	
II. 22. 28. 52·41	3. 9. 50·18	69. 58. 10·7	60. 20·0	16. 28·1	40. 35. 54·15	38. 48. 27·4	23·9
I. 22. 36. 3·93	3. 10. 7·81	69. 56. 39·4	60. 20·1	16. 28·1	42. 34. 40·20	40. 39. 47·0	
II. 22. 37. 3·77	3. 10. 10·26	69. 56. 26·7	60. 20·1	16. 28·1	42. 34. 3·45	40. 39. 10·7	26·3
I. 22. 43. 20·64	3. 10. 25·69	69. 55. 7·0	60. 20·1	16. 28·1	44. 19. 40·65	42. 18. 2·8	
II. 22. 44. 20·48	3. 10. 28·14	69. 54. 54·3	60. 20·1	16. 28·1	44. 19. 3·90	42. 17. 26·7	25·4
——	4. 28. 45·64	73. 44. 29·9	—	—	28. 11. 22·50	27. 7. 17·0	—
——	,,	,,	—	—	30. 11. 32·40	28. 58. 45·3	—
I. 23. 55. 6·53	4. 14. 31·63	65. 20. 20·0	60. 20·6	16. 28·2	47. 16. 45·15	44. 25. 36·3	
II. 23. 56. 6·37	4. 14. 34·25	65. 20. 11·1	60. 20·6	16. 28·2	47. 16. 5·85	44. 24. 59·6	23·5
I. 0. 5. 21·27	4. 14. 58·51	65. 18. 47·1	60. 20·6	16. 28·2	49. 44. 8·25	46. 40. 18·6	
II. 0. 6. 21·11	4. 15. 1·13	65. 18. 38·2	60. 20·6	16. 28·2	49. 43. 28·95	46. 39. 42·1	28·0
I. 0. 15. 36·20	4. 15. 25·46	65. 17. 16·1	60. 20·5	16. 28·2	52. 11. 33·30	48. 54. 44·0	
II. 0. 16. 36·04	4. 15. 28·08	65. 17. 7·2	60. 20·5	16. 28·2	52. 10. 54·00	48. 54. 7·6	22·4
I. 0. 29. 13·60	4. 16. 1·29	65. 15. 15·6	60. 20·5	16. 28·2	55. 27. 30·30	51. 52. 53·4	
II. 0. 30. 13·44	4. 16. 3·91	65. 15. 6·8	60. 20·5	16. 28·2	55. 26. 51·00	51. 52. 17·0	30·8
I. 1. 8. 54·68	4. 17. 45·77	65. 9. 27·8	60. 20·2	16. 28·1	64. 58. 17·10	60. 27. 55·0	
II. 1. 9. 54·52	4. 17. 48·41	65. 9. 19·1	60. 20·2	16. 28·1	64. 57. 37·50	60. 27. 18·0	27·0
I. 1. 16. 46·63	4. 18. 6·49	65. 8. 19·4	60. 20·2	16. 28·1	66. 51. 24·90	62. 9. 12·7	
II. 1. 17. 46·47	4. 18. 9·14	65. 8. 10·7	60. 20·2	16. 28·1	66. 50. 45·15	62. 8. 35·6	27·8
I. 0. 20. 24·76	5. 20. 9·66	62. 37. 27·1	60. 5·8	16. 24·2	38. 11. 58·80	36. 3. 23·6	
II. 0. 21. 24·60	5. 20. 12·39	62. 37. 22·8	60. 5·8	16. 24·2	38. 11. 17·85	36. 2. 47·3	28·1
I. 0. 27. 52·30	5. 20. 30·05	62. 36. 55·1	60. 5·7	16. 24·2	39. 59. 4·35	37. 39. 49·7	
II. 0. 28. 52·14	5. 20. 32·77	62. 36. 50·9	60. 5·7	16. 24·2	39. 58. 23·55	37. 39. 13·6	25·4
I. 0. 36. 3·78	5. 20. 52·42	62. 36. 20·3	60. 5·6	16. 24·2	41. 56. 41·25	39. 25. 42·2	
II. 0. 37. 3·62	5. 20. 55·15	62. 36. 16·0	60. 5·6	16. 24·2	41. 56. 0·30	39. 25. 5·9	26·6
I. 0. 47. 32·28	5. 21. 23·78	62. 35. 31·8	60. 5·4	16. 24·1	44. 41. 26·70	41. 53. 54·0	
II. 0. 48. 32·12	5. 21. 26·51	62. 35. 27·6	60. 5·4	16. 24·1	44. 40. 45·75	41. 53. 17·5	29·3
I. 0. 54. 54·92	5. 21. 43·95	62. 35. 0·9	60. 5·3	16. 24·1	46. 27. 21·75	43. 29. 4·4	
II. 0. 55. 54·75	5. 21. 46·68	62. 34. 56·7	60. 5·3	16. 24·1	46. 26. 40·80	43. 28. 27·8	28·8
I. 1. 2. 20·91	5. 22. 4·27	62. 34. 29·9	60. 5·2	16. 24·0	48. 14. 5·10	45. 4. 52·3	
II. 1. 3. 20·74	5. 22. 7·00	62. 34. 25·8	60. 5·2	16. 24·0	48. 13. 24·15	45. 4. 16·0	26·9
——	6. 30. 30·27	73. 29. 38·1	—	—	37. 8. 31·80	35. 23. 3·0	—
——	,,	,,	—	—	39. 16. 9·45	37. 21. 56·8	—
——	,,	,,	—	—	42. 5. 58·50	40. 0. 9·8	—

Day.	Observer.	Object.	Altazimuth-Clock Time of Vertical Transit over Mean of Horizontal Wires.	Lamp Right or Left.	Reading of Vertical Circle corrected for Runs of Micrometers.	Level Indication (additive).	Barometer and External Thermometer.	Refraction.	True observed Zenith Distance.
1874.			h m s		° ′ ″	″		″	° ′ ″
December 22	T	Moon's U. L. ...	4. 3. 4·74	L	300. 45. 40·9	91·3	60°·0	33·6	30. 47. 19·4
		,, L. L. ...	4. 5. 40·82	L	300. 45. 40·9	91·3	29in·94	33·6	30. 47. 19·4
		,, U. L. ...	4. 14. 39·74	L	298. 18. 8·6	91·4		30·4	28. 19. 44·0
		,, L. L. ...	4. 17. 16·62	L	298. 18. 8·6	91·4		30·4	28. 19. 44·0
		,, U. L. ...	4. 23. 31·98	L	296. 25. 35·8	91·6		28·0	26. 27. 9·0
		,, L. L. ...	4. 26. 9·28	L	296. 25. 35·8	91·6		28·0	26. 27. 9·0
		,, U. L. ...	4. 33. 9·90	R	245. 34. 41·0	53·0		25·6	24. 25. 18·0
		,, L. L. ...	4. 35. 48·06	R	245. 34. 41·0	53·0		25·6	24. 25. 18·0
		,, U. L. ...	4. 42. 52·12	R	247. 36. 34·0	51·5		23·2	22. 23. 24·1
		,, L. L. ...	4. 45. 30·84	R	247. 36. 34·0	51·5		23·2	22. 23. 24·1
		,, U. L. ...	5. 0. 25·74	R	251. 14. 24·2	50·6	29in·93	19·1	18. 45. 30·7
		,, L. L. ...	5. 3. 7·78	R	251. 14. 24·2	50·6	60°·8	19·1	18. 45. 30·7
24	NI	Moon's L. L. ...	4. 35. 42·96	R	217. 17. 2·7	55·4	59°·0	74·2	52. 43. 42·5
		,, ...	4. 43. 10·56	R	218. 54. 26·6	55·5		70·0	51. 6. 14·3
		,, ...	4. 49. 42·74	R	220. 20. 0·5	55·5		66·5	49. 40. 36·9
		,, ...	4. 58. 26·42	L	317. 44. 2·6	87·9		62·2	47. 46. 6·3
		,, ...	5. 6. 31·72	L	315. 57. 49·4	88·5	30in·00	58·5	45. 59. 50·0
		,, ...	5. 13. 41·30	L	314. 23. 34·5	88·8	59°·5	55·3	44. 25. 32·2

	° ′ ″
December 22. The adopted Zenith point corresponding to the mean wire is	270. 0. 26·4
December 24. ,, ,, ,,	270. 0. 26·4

Greenwich Mean Solar Time, assuming the West Longitude to be I. 10h. 31m. 0s. II. 10h. 32m. 0s.	Tabular Geocentric Elements (R. A. and N. P. D. corrected). Apparent Right Ascension of Center.	Apparent North Polar Distance of Center.	Equatorial Horizontal Parallax.	Semi-diameter.	Hour-Angle.	Tabular Zenith Distance of Star or of Limb of Moon.	Inferred Longitude West of Greenwich 10h. 31m. +
h m s	h m s	° ′ ″	′ ″	′ ″	° ′ ″	° ′ ″	s
I. 20. 27. 54·00	6. 15. 19·03	61. 52. 27·5	59. 42·5	16. 17·9	32. 53. 27·75	30. 47. 11·9	
II. 20. 28. 53·84	6. 15. 21·75	61. 52. 27·4	59. 42·5	16. 17·9	32. 54. 8·55	30. 47. 47·7	12·6
I. 20. 30. 29·65	6. 15. 26·13	61. 52. 27·0	59. 42·4	16. 17·8	32. 16. 13·05	30. 47. 6·5	
II. 20. 31. 29·48	6. 15. 28·85	61. 52. 26·9	59. 42·4	16. 17·8	32. 16. 53·85	30. 47. 42·2	21·7
I. 20. 39. 27·09	6. 15. 50·61	61. 52. 25·8	59. 42·2	16. 17·8	30. 7. 36·45	28. 19. 36·5	
II. 20. 40. 26·93	6. 15. 53·34	61. 52. 25·7	59. 42·2	16. 17·8	30. 8. 17·40	28. 20. 12·4	12·5
I. 20. 42. 3·55	6. 15. 57·74	61. 52. 25·5	59. 42·2	16. 17·8	29. 30. 10·20	28. 19. 27·8	
II. 20. 43. 3·38	6. 16. 0·47	61. 52. 25·3	59. 42·2	16. 17·8	29. 30. 51·15	28. 20. 3·8	26·9
I. 20. 48. 17·88	6. 16. 14·81	61. 52. 24·8	59. 42·0	16. 17·7	28. 0. 35·85	26. 26. 57·3	
II. 20. 49. 17·72	6. 16. 17·54	61. 52. 24·7	59. 42·0	16. 17·7	28. 1. 16·80	26. 27. 33·1	19·6
I. 20. 50. 54·75	6. 16. 21·96	61. 52. 24·5	59. 42·0	16. 17·7	27. 23. 3·60	26. 26. 51·1	
II. 20. 51. 54·59	6. 16. 24·68	61. 52. 24·4	59. 42·0	16. 17·7	27. 23. 44·40	26. 27. 26·6	30·2
I. 20. 57. 54·22	6. 16. 41·07	61. 52. 23·9	59. 41·8	16. 17·7	25. 42. 40·95	24. 25. 8·9	
II. 20. 58. 54·06	6. 16. 43·80	61. 52. 23·9	59. 41·8	16. 17·7	25. 43. 21·90	24. 25. 44·4	15·4
I. 21. 0. 31·95	6. 16. 48·26	61. 52. 23·8	59. 41·8	16. 17·7	25. 4. 56·40	24. 25. 2·9	
II. 21. 1. 31·79	6. 16. 50·98	61. 52. 23·7	59. 41·8	16. 17·7	25. 5. 37·20	24. 25. 38·1	25·7
I. 21. 7. 34·86	6. 17. 7·53	61. 52. 23·4	59. 41·6	16. 17·6	23. 23. 44·55	22. 23. 10·5	
II. 21. 8. 34·69	6. 17. 10·25	61. 52. 23·4	59. 41·6	16. 17·6	23. 24. 25·35	22. 23. 45·2	23·5
I. 21. 10. 13·15	6. 17. 14·74	61. 52. 23·4	59. 41·5	16. 17·6	22. 45. 51·90	22. 23. 12·4	
II. 21. 11. 12·98	6. 17. 17·47	61. 52. 23·3	59. 41·5	16. 17·6	22. 46. 32·85	22. 23. 47·0	20·3
I. 21. 25. 5·60	6. 17. 55·40	61. 52. 23·3	59. 41·2	16. 17·5	19. 12. 18·30	18. 45. 16·3	
II. 21. 26. 5·43	6. 17. 58·12	61. 52. 23·3	59. 41·2	16. 17·5	19. 12. 59·10	18. 45. 50·7	25·1
I. 21. 27. 47·20	6. 18. 2·76	61. 52. 23·4	59. 41·1	16. 17·5	18. 33. 38·10	18. 45. 20·5	
II. 21. 28. 47·04	6. 18. 5·48	61. 52. 23·4	59. 41·1	16. 17·5	18. 34. 18·90	18. 45. 54·7	17·9
I. 20. 52. 35·70	8. 22. 0·24	65. 24. 46·8	58. 15·9	15. 54·2	56. 24. 2·55	52. 43. 26·1	
II. 20. 53. 35·54	8. 22. 2·68	65. 24. 55·2	58. 15·9	15. 54·2	56. 24. 39·15	52. 44. 0·2	28·9
I. 21. 0. 2·09	8. 22. 18·43	65. 25. 49·3	58. 15·6	15. 54·1	54. 36. 41·40	51. 5. 56·0	
II. 21. 1. 1·92	8. 22. 20·86	65. 25. 57·7	58. 15·6	15. 54·1	54. 37. 17·85	51. 6. 30·1	32·2
I. 21. 6. 33·35	8. 22. 34·36	65. 26. 44·2	58. 15·4	15. 54·0	53. 2. 37·65	49. 40. 21·1	
II. 21. 7. 33·19	8. 22. 36·80	65. 26. 52·6	58. 15·4	15. 54·0	53. 3. 14·25	49. 40. 55·2	27·8
I. 21. 15. 15·45	8. 22. 55·61	65. 27. 57·6	58. 15·1	15. 54·0	50. 57. 1·20	47. 45. 51·3	
II. 21. 16. 15·28	8. 22. 58·05	65. 28. 6·0	58. 15·1	15. 54·0	50. 57. 37·80	47. 46. 25·4	26·4
I. 21. 23. 19·42	8. 23. 15·30	65. 29. 5·8	58. 14·8	15. 53·9	49. 0. 36·90	45. 59. 32·0	
II. 21. 24. 19·26	8. 23. 17·74	65. 29. 14·2	58. 14·8	15. 53·9	49. 1. 13·50	46. 0. 6·0	31·8
I. 21. 30. 27·84	8. 23. 32·73	65. 30. 6·3	58. 14·6	15. 53·8	47. 17. 34·65	44. 25. 15·9	
II. 21. 31. 27·67	8. 23. 35·16	65. 30. 14·7	58. 14·6	15. 53·8	47. 18. 11·10	44. 25. 49·8	28·8

December 22. Cloudy. Aperture reduced for some of the observations.

Day.	Observer.	Object.	Altazimuth-Clock Time of Vertical Transit over Mean of Horizontal Wires.	Lamp Right or Left.	Reading of Vertical Circle corrected for Runs of Micrometers.	Level Indication (additive).	Barometer and External Thermometer.	Refraction.	True observed Zenith Distance.
1874.			h. m. s.		° ′ ″	″		″	° ′ ″
December 26	NI	Moon's L. L. ...	6. 49. 12·44	L	319. 30. 36·9	82·6	67°·1	65·5	49. 32. 39·6
		,, ...	6. 57. 35·78	L	317. 36. 42·2	82·2	68°·0	61·2	47. 38. 40·2
		,, ...	7. 10. 41·30	L	314. 38. 46·0	81·6	30in·08	55·2	44. 40. 37·4
		,, ...	7. 20. 9·32	R	227. 28. 29·4	62·4		51·2	42. 31. 44·8
		,, ...	7. 30. 45·74	R	229. 52. 46·6	62·3		47·1	40. 7. 23·6
		,, ...	7. 38. 57·00	R	231. 44. 9·2	62·3	68°·2	44·1	38. 15. 58·0
		δ Leonis	8. 8. 20·64	R	228. 34. 36·6	60·0		49·3	41. 25. 38·1
		,, ...	8. 18. 13·16	L	309. 7. 17·9	81·6	67°·8	45·5	39. 8. 59·6
29	NI	Moon's L. L. ...	7. 30. 53·24	L	347. 3. 12·8	77·7	63°·4	240·3	77. 8. 3·4
		,, ...	7. 39. 47·02	L	345. 4. 28·8	77·6		208·4	75. 8. 47·4
		,, ...	7. 50. 1·36	L	342. 47. 59·2	78·2	63°·1	180·2	72. 51. 50·2
		,, ...	8. 0. 19·46	R	199. 27. 31·2	66·7		158·0	70. 34. 27·5
		,, ...	8. 10. 17·66	R	201. 39. 50·9	66·6	30in·09	140·8	68. 21. 50·7
		,, ...	8. 18. 34·60	R	203. 29. 28·8	66·2	63°·5	128·8	66. 32. 1·2
30	NI	Moon's L. L. ...	9. 19. 4·72	L	335. 19. 28·6	76·8	65°·0	121·8	65. 22. 19·8
		,, ...	9. 27. 36·70	L	333. 31. 30·3	76·9		112·5	63. 34. 12·3
		,, ...	9. 36. 12·82	L	331. 43. 26·8	76·9		104·4	61. 46. 0·7
		Spica.........	9. 44. 29·68	L	331. 13. 53·7	76·4	64°·2	102·3	61. 16. 25·0
		,, ...	9. 53. 21·70	R	210. 35. 18·3	68·9		94·9	59. 25. 35·1
		Moon's L. L. ...	10. 3. 35·84	R	213. 52. 24·1	67·6		83·7	56. 8. 19·4

December 26. The adopted Zenith point corresponding to the mean wire is 270. 0. 25·4 (° ′ ″)
December 29 and December 30. The adopted Zenith point corresponding to the mean wire is 270°. 0′. 27″·4

Greenwich Mean Solar Time, assuming the West Longitude to be I. 10h. 31m. 0s. II. 10h. 32m. 0s.	Tabular Geocentric Elements (R. A. and N. P. D. corrected). Apparent Right Ascension of Center.	Apparent North Polar Distance of Center.	Equatorial Horizontal Parallax.	Semi-diameter.	Hour-Angle.	Tabular Zenith Distance of Star or of Limb of Moon.	Inferred Longitude West of Greenwich 10h. 31m. +
h m s	h m s	° ′ ″	′ ″	′ ″	° ′ ″	° ′ ″	s
I. 22. 57. 52·00	10. 13. 49·76	74. 39. 42·7	56. 30·1	15. 25·3	50. 58. 55·50	49. 32. 22·9	
II. 22. 58. 51·84	10. 13. 51·79	74. 39. 55·7	56. 30·1	15. 25·3	50. 59. 25·95	49. 32. 54·7	31·5
I. 23. 6. 13·97	10. 14. 6·79	74. 41. 31·9	56. 29·8	15. 25·2	48. 57. 20·85	47. 38. 23·0	
II. 23. 7. 13·81	10. 14. 8·81	74. 41. 44·9	56. 29·8	15. 25·2	48. 57. 51·15	47. 38. 54·6	32·7
I. 23. 19. 17·35	10. 14. 33·34	74. 44. 22·4	56. 29·4	15. 25·1	45. 47. 36·30	44. 40. 19·1	
II. 23. 20. 17·19	10. 14. 35·37	74. 44. 35·5	56. 29·4	15. 25·1	45. 48. 6·75	44. 40. 51·0	34·4
I. 23. 28. 43·82	10. 14. 52·53	74. 46. 25·9	56. 29·0	15. 25·0	43. 30. 23·70	42. 31. 28·8	
II. 23. 29. 43·66	10. 14. 54·56	74. 46. 38·9	56. 29·0	15. 25·0	43. 30. 54·15	42. 32. 0·6	30·2
I. 23. 39. 18·50	10. 15. 14·02	74. 48. 44·2	56. 28·7	15. 24·9	40. 56. 39·75	40. 7. 6·2	
II. 23. 40. 18·34	10. 15. 16·05	74. 48. 57·3	56. 28·7	15. 24·9	40. 57. 10·20	40. 7. 38·0	32·8
I. 23. 47. 28·42	10. 15. 30·60	74. 50. 31·1	56. 28·4	15. 24·8	38. 57. 59·55	38. 15. 40·5	
II. 23. 48. 28·26	10. 15. 32·62	74. 50. 44·2	56. 28·4	15. 24·8	38. 58. 29·85	38. 16. 12·1	33·2
——	11. 7. 27·74	68. 47. 33·9	—	—	44. 36. 22·05	41. 25. 37·2	—
——	,,	,,	—	—	42. 8. 14·25	39. 8. 58·6	—
I. 23. 27. 38·99	12. 28. 48·84	91. 34. 0·7	54. 36·8	14. 54·4	74. 18. 18·30	77. 7. 48·1	
II. 23. 28. 38·83	12. 28. 50·60	91. 34. 14·8	54. 36·8	14. 54·4	74. 18. 44·70	77. 8. 17·9	30·8
I. 23. 36. 31·32	12. 29. 4·48	91. 36. 6·1	54. 36·7	14. 54·4	72. 8. 46·20	75. 8. 34·2	
II. 23. 37. 31·15	12. 29. 6·24	91. 36. 20·2	54. 36·7	14. 54·4	72. 9. 12·60	75. 9. 4·0	26·6
I. 23. 46. 43·97	12. 29. 22·49	91. 38. 30·4	54. 36·5	14. 54·4	69. 39. 41·40	72. 51. 37·1	
II. 23. 47. 43·81	12. 29. 24·25	91. 38. 44·5	54. 36·5	14. 54·4	69. 40. 7·80	72. 52. 6·9	26·4
I. 23. 57. 0·38	12. 29. 40·60	91. 40. 55·6	54. 36·4	14. 54·3	67. 9. 41·55	70. 34. 10·7	
II. 23. 58. 0·21	12. 29. 42·36	91. 41. 9·7	54. 36·4	14. 54·3	67. 10. 7·95	70. 34. 40·5	33·8
I. 0. 6. 56·95	12. 29. 58·18	91. 43. 17·2	54. 36·2	14. 54·3	64. 44. 32·25	68. 21. 35·0	
II. 0. 7. 56·79	12. 29. 59·94	91. 43. 31·3	54. 36·2	14. 54·3	64. 44. 58·65	68. 22. 4·8	31·6
I. 0. 15. 12·52	12. 30. 12·75	91. 45. 13·9	54. 36·1	14. 54·2	62. 43. 56·85	66. 31. 46·3	
II. 0. 16. 12·35	12. 30. 14·50	91. 45. 28·0	54. 36·1	14. 54·2	62. 44. 23·10	66. 32. 16·0	30·1
I. 1. 11. 37·43	13. 14. 11·99	97. 31. 20·0	54. 17·5	14. 49·1	58. 36. 4·50	65. 22. 3·8	
II. 1. 12. 37·26	13. 14. 13·76	97. 31. 33·5	54. 17·5	14. 49·1	58. 36. 31·05	65. 22. 33·4	32·4
I. 1. 20. 7·99	13. 14. 27·07	97. 33. 15·4	54. 17·4	14. 49·1	56. 31. 51·15	63. 33. 56·5	
II. 1. 21. 7·83	13. 14. 28·85	97. 33. 28·9	54. 17·4	14. 49·1	56. 32. 17·85	63. 34. 26·2	31·9
I. 1. 28. 42·69	13. 14. 42·28	97. 35. 11·6	54. 17·3	14. 49·1	54. 26. 37·80	61. 45. 46·8	
II. 1. 29. 42·53	13. 14. 44·05	97. 35. 25·1	54. 17·3	14. 49·1	54. 27. 4·35	61. 46. 16·4	28·2
——	13. 18. 35·81	100. 30. 27·7	—	—	53. 20. 48·15	61. 16. 25·3	—
——	,,	,,	—	—	51. 7. 48·15	59. 25. 35·5	—
I. 1. 56. 1·17	13. 15. 30·70	97. 41. 21·5	54. 17·1	14. 49·0	47. 47. 59·70	56. 8. 4·8	
II. 1. 57. 1·00	13. 15. 32·47	97. 41. 35·0	54. 17·1	14. 49·0	47. 48. 26·25	56. 8. 34·3	29·7

December 26. Very cloudy.

Day.	Observer.	Object.	Altazimuth-Clock Time of Vertical Transit over Mean of Horizontal Wires.	Lamp Right or Left.	Reading of Vertical Circle corrected for Runs of Micrometers.	Level Indication (additive).	Barometer and External Thermometer.	Refraction.	True observed Zenith Distance.
			h m s		° ′ ″	″		″	° ′ ″
1874. December 30	NI	Moon's L. L. ...	10. 11. 31·70	R	215. 27. 55·0	67·4	30in·10	78·9	54. 32. 43·9
		,, ...	10. 20. 4·64	R	217. 9. 29·3	67·1	63°·6	74·2	52. 51. 5·2
31	NI	Moon's L. L. ...	9. 40. 31·08	R	197. 18. 59·4	62·2	63°·1	178·6	72. 43. 24·4
		,, ...	9. 48. 45·80	R	199. 1. 17·3	62·9		161·8	71. 0. 49·0
		,, ...	9. 58. 45·32	R	201. 4. 20·2	63·4		145·0	68. 57. 28·8
		,, ...	10. 8. 44·36	L	336. 52. 27·1	77·4	62°·1	131·2	66. 55. 28·3
		,, ...	10. 17. 36·70	L	335. 5. 20·8	78·2		120·8	65. 8. 12·4
		,, ...	10. 25. 48·62	L	332. 27. 30·4	78·2	62°·7	107·7	62. 30. 8·9
		α^2 Libræ	10. 38. 29·16	L	340. 20. 16·5	79·7	30in·05	156·4	70. 23. 45·2
		,, ...	10. 47. 22·30	R	201. 28. 40·9	68·3	62°·6	142·0	68. 33. 0·2
1875. January 1	NI	α^2 Libræ	10. 10. 24·52	R	193. 42. 56·0	62·0	60°·1	226·6	76. 20. 16·0
		,, ...	10. 19. 35·50	L	344. 18. 20·7	81·4		198·2	74. 22. 32·9
		Moon's L. L. ...	10. 30. 18·50	L	344. 18. 21·0	81·8	60°·0	198·3	74. 22. 33·7
		,, ...	10. 36. 48·36	L	343. 1. 5·6	82·6		182·8	73. 5. 3·6
		,, ...	10. 43. 48·84	L	341. 38. 20·4	82·6		168·4	71. 42. 4·0
		,, ...	10. 52. 17·48	R	199. 59. 18·4	65·6	60°·7	153·5	70. 2. 36·9
		,, ...	11. 0. 17·50	R	201. 31. 53·9	65·1	29in·97	141·7	68. 29. 50·1
		,, ...	11. 7. 48·58	R	202. 57. 54·2	65·0	61°·1	132·0	67. 3. 40·2
11	T	Moon's L. L. ...	2. 55. 16·46	R	208. 26. 57·3	69·4	62°·0	103·6	61. 34. 3·3

		° ′ ″
December 31.	The adopted Zenith point corresponding to the mean wire is	270. 0. 27·4
January 1.	,, ,, ,,	270. 0. 27·4
January 11.	,, ,, ,,	270. 0. 26·4

Greenwich Mean Solar Time, assuming the West Longitude to be I. 10h. 31m. 0s. II. 10h. 32m. 0s.	Tabular Geocentric Elements (R. A. and N. P. D. corrected).				Hour-Angle.	Tabular Zenith Distance of Star or of Limb of Moon.	Inferred Longitude West of Greenwich 10h. 31m. +
	Apparent Right Ascension of Center.	Apparent North Polar Distance of Center.	Equatorial Horizontal Parallax.	Semi-diameter.			
h m s	h m s	° ′ ″	′ ″	′ ″	° ′ ″	° ′ ″	s
I. 2. 3. 55·71	13. 15. 44·73	97. 43. 8·6	54. 17·0	14. 49·0	45. 52. 32·55	54. 32. 30·7	
II. 2. 4. 55·54	13. 15. 46·50	97. 43. 22·1	54. 17·0	14. 49·0	45. 52. 59·10	54. 33. 0·1	26·9
I. 2. 12. 27·22	13. 15. 59·85	97. 45. 3·9	54. 16·9	14. 49·0	43. 48. 5·55	52. 50. 49·5	
II. 2. 13. 27·06	13. 16. 1·62	97. 45. 17·4	54. 16·9	14. 49·0	43. 48. 32·10	52. 51. 18·7	32·3
I. 1. 29. 4·96	13. 57. 49·61	102. 50. 8·4	54. 10·2	14. 47·2	64. 8. 44·40	72. 43. 11·7	
II. 1. 30. 4·80	13. 57. 51·43	102. 50. 20·9	54. 10·2	14. 47·2	64. 9. 11·70	72. 43. 41·0	26·0
I. 1. 37. 18·33	13. 58. 4·63	102. 51. 52·1	54. 10·1	14. 47·2	62. 8. 48·90	71. 0. 34·3	
II. 1. 38. 18·17	13. 58. 6·45	102. 52. 4·7	54. 10·1	14. 47·2	62. 9. 16·20	71. 1. 3·7	30·0
I. 1. 47. 16·22	13. 58. 22·84	102. 53. 57·7	54. 10·1	14. 47·2	59. 43. 29·25	68. 57. 15·2	
II. 1. 48. 16·05	13. 58. 24·66	102. 54. 10·3	54. 10·1	14. 47·2	59. 43. 56·55	68. 57. 44·6	27·8
I. 1. 57. 13·63	13. 58. 41·04	102. 56. 3·2	54. 10·1	14. 47·1	57. 18. 16·50	66. 55. 17·0	
II. 1. 58. 13·46	13. 58. 42·86	102. 56. 15·7	54. 10·1	14. 47·1	57. 18. 43·80	66. 55. 46·3	23·1
I. 2. 6. 4·51	13. 58. 57·22	102. 57. 54·6	54. 10·1	14. 47·1	55. 9. 14·10	65. 8. 3·4	
II. 2. 7. 4·35	13. 58. 59·04	102. 58. 7·2	54. 10·1	14. 47·1	55. 9. 41·40	65. 8. 32·6	18·5
I. 2. 19. 14·27	13. 59. 21·29	103. 0. 52·24	54. 10·1	14. 47·1	51. 57. 16·35	62. 30. 53·4	
II. 2. 20. 14·11	13. 59. 23·11	103. 1. 4·79	54. 10·1	14. 47·1	51. 57. 43·65	62. 31. 22·6	31·8
—	14. 43. 56·72	105. 31. 15·7	—	—	61. 10. 59·70	70. 23. 47·2	—
—	,,	,,	—	—	58. 57. 42·60	68. 33. 3·6	—
—	14. 43. 56·75	105. 31. 15·9	—	—	68. 11. 58·05	76. 20. 17·1	—
—	,,	,,	—	—	65. 54. 13·35	74. 22. 35·7	—
I. 2. 14. 49·09	14. 44. 9·81	107. 46. 9·8	54. 13·2	14. 48·0	63. 16. 44·25	74. 22. 20·8	
II. 2. 15. 48·93	14. 44. 11·72	107. 46. 21·0	54. 13·2	14. 48·0	63. 17. 12·90	74. 22. 50·0	26·5
I. 2. 21. 17·89	14. 44. 22·26	107. 47. 22·4	54. 13·2	14. 48·0	61. 42. 23·10	73. 4. 48·5	
II. 2. 22. 17·73	14. 44. 24·18	107. 47. 33·6	54. 13·2	14. 48·0	61. 42. 51·90	73. 5. 17·7	31·0
I. 2. 28. 17·22	14. 44. 35·70	107. 48. 40·6	54. 13·3	14. 48·0	60. 0. 37·50	71. 41. 49·9	
II. 2. 29. 17·06	14. 44. 37·62	107. 48. 51·8	54. 13·3	14. 48·0	60. 1. 6·30	71. 42. 19·2	28·9
I. 2. 36. 44·47	14. 44. 51·96	107. 50. 15·2	54. 13·3	14. 48·0	57. 57. 31·80	70. 2. 25·3	
II. 2. 37. 44·30	14. 44. 53·88	107. 50. 26·4	54. 13·3	14. 48·0	57. 58. 0·60	70. 2. 54·4	23·9
I. 2. 44. 43·18	14. 45. 7·32	107. 51. 44·4	54. 13·4	14. 48·0	56. 1. 21·90	68. 29. 38·8	
II. 2. 45. 43·01	14. 45. 9·23	107. 51. 55·5	54. 13·4	14. 48·0	56. 1. 50·55	68. 30. 7·6	23·5
I. 2. 52. 13·03	14. 45. 21·74	107. 53. 8·1	54. 13·4	14. 48·0	54. 12. 12·00	67. 3. 26·8	
II. 2. 53. 12·87	14. 45. 23·66	107. 53. 19·3	54. 13·4	14. 48·0	54. 12. 40·80	67. 3. 55·9	27·6
I. 18. 1. 49·42	23. 19. 17·34	97. 27. 14·7	58. 19·6	15. 55·2	54. 12. 36·60	61. 34. 19·7	
II. 18. 2. 49·25	23. 19. 19·39	97. 26. 59·0	58. 19·6	15. 55·2	54. 12. 5·85	61. 33. 45·4	28·7

Day.	Observer.	Object.	Altazimuth-Clock Time of Vertical Transit over Mean of Horizontal Wires.	Lamp Right or Left.	Reading of Vertical Circle corrected for Runs of Micrometers.	Level Indication (additive).	Barometer and External Thermometer.	Refraction.	True observed Zenith Distance.
1875.			h m s		° ′ ″	″		″	° ′ ″
January 11	T	Moon's L. L. ...	3. 9. 13·60	R	205. 32. 15·5	69·9	30in·00	117·3	64. 28. 58·3
		,, ...	3. 16. 18·50	R	204. 2. 52·4	69·9		125·5	65. 58. 29·6
		,, ...	3. 22. 41·08	L	337. 16. 36·8	69·4		133·9	67. 19. 33·7
		,, ...	3. 28. 51·50	L	338. 35. 17·4	70·2		143·3	68. 38. 24·5
		,, ...	3. 36. 25·68	L	340. 12. 9·1	70·4	61°·0	156·0	70. 15. 29·1
13	NI	Moon's L. L. ...	3. 58. 1·50	R	222. 58. 55·2	69·0	61°·2	60·4	47. 1. 22·6
		,, ...	4. 6. 56·28	R	221. 1. 9·4	68·9		64·7	48. 59. 12·8
		,, ...	4. 15. 34·10	R	219. 6. 40·4	69·2		69·3	50. 53. 46·1
		,, ...	4. 23. 6·08	L	322. 32. 1·8	70·6		73·7	52. 33. 59·7
		,, ...	4. 30. 37·86	L	324. 12. 29·5	71·2		78·1	54. 14. 32·4
		,, ...	4. 38. 36·30	L	325. 59. 5·3	71·3		83·5	56. 1. 13·7
		β Arietis	4. 48. 19·92	L	312. 15. 54·5	70·8	29in·97	51·4	42. 17. 30·3
		,, ...	4. 56. 40·58	R	225. 46. 57·1	72·7	59°·9	54·9	44. 13. 11·5
14	NI	Moon's L. L. ...	4. 34. 22·14	R	229. 2. 40·4	71·1	65°·9	48·4	40. 57. 23·3
		,, ...	4. 41. 10·42	R	227. 30. 52·3	70·5		51·1	42. 29. 14·7
		,, ...	4. 47. 31·76	R	226. 5. 5·6	70·0	65°·2	53·7	43. 55. 4·5
		,, ...	5. 12. 50·44	L	319. 35. 37·5	73·4		65·5	49. 37. 30·0
		,, ...	5. 20. 20·42	L	321. 17. 3·6	73·0	29in·94	69·4	51. 18. 59·6
		,, ...	5. 27. 5·72	L	322. 48. 26·9	73·4	67°·8	73·2	52. 50. 27·1

January 11 to January 14. The adopted Zenith point corresponding to the mean wire is 270° 0′ 26″·4

Greenwich Mean Solar Time, assuming the West Longitude to be I. 10h. 31m. 0s. II. 10h. 32m. 0s.	Tabular Geocentric Elements (R. A. and N. P. D. corrected). Apparent Right Ascension of Center.	Apparent North Polar Distance of Center.	Equatorial Horizontal Parallax.	Semi-diameter.	Hour-Angle.	Tabular Zenith Distance of Star or of Limb of Moon.	Inferred Longitude West of Greenwich 10h. 31m. +
h m s	h m s	° ′ ″	′ ″	′ ″	° ′ ″	° ′ ″	s
I. 18. 15. 44·27	23. 19. 45·93	97. 23. 35·6	58. 19·8	15. 55·3	57. 34. 45·00	64. 29. 12·2	
II. 18. 16. 44·11	23. 19. 47·98	97. 23. 19·9	58. 19·8	15. 55·3	57. 34. 14·25	64. 28. 37·9	24·3
I. 18. 22. 48·02	23. 20. 0·43	97. 21. 44·3	58. 19·9	15. 55·3	59. 17. 21·00	65. 58. 46·5	
II. 18. 23. 47·85	23. 20. 2·50	97. 21. 28·6	58. 19·9	15. 55·3	59. 16. 49·95	65. 58. 11·9	29·5
I. 18. 28. 59·58	23. 20. 13·50	97. 20. 4·1	58. 20·0	15. 55·4	60. 49. 43·65	67. 19. 50·5	
II. 18. 29. 59·42	23. 20. 15·55	97. 19. 48·4	58. 20·0	15. 55·4	60. 49. 12·90	67. 19. 16·2	29·4
I. 18. 35. 18·97	23. 20. 26·13	97. 18. 27·1	58. 20·1	15. 55·4	62. 19. 10·65	68. 38. 41·4	
II. 18. 36. 18·81	23. 20. 28·18	97. 18. 11·4	58. 20·1	15. 55·4	62. 18. 39·90	68. 38. 7·2	29·6
I. 18. 42. 51·91	23. 20. 41·65	97. 16. 28·0	58. 20·2	15. 55·4	64. 8. 50·55	70. 15. 47·5	
II. 18. 43. 51·75	23. 20. 43·69	97. 16. 12·3	58. 20·2	15. 55·4	64. 8. 19·95	70. 15. 13·3	32·3
I. 18. 56. 33·34	0. 59. 34·84	84. 11. 29·8	58. 58·7	16. 5·9	44. 49. 44·55	47. 1. 41·1	
II. 18. 57. 33·18	0. 59. 36·92	84. 11. 13·6	58. 58·7	16. 5·9	44. 49. 13·35	47. 1. 6·1	31·7
I. 19. 5. 26·64	0. 59. 53·34	84. 9. 5·3	58. 58·8	16. 5·9	46. 58. 48·45	48. 59. 31·2	
II. 19. 6. 26·48	0. 59. 55·42	84. 8. 49·1	58. 58·8	16. 5·9	46. 58. 17·25	48. 58. 56·2	31·8
I. 19. 14. 3·04	1. 0. 11·26	84. 6. 45·4	58. 58·9	16. 6·0	49. 3. 46·80	50. 54. 4·9	
II. 19. 15. 2·88	1. 0. 13·34	84. 6. 29·1	58. 58·9	16. 6·0	49. 3. 15·60	50. 53. 30·0	32·3
I. 19. 21. 33·77	1. 0. 26·91	84. 4. 43·2	58. 59·0	16. 6·0	50. 52. 51·60	52. 34. 23·7	
II. 19. 22. 33·61	1. 0. 28·98	84. 4. 27·0	58. 59·0	16. 6·0	50. 52. 20·55	52. 33. 48·9	41·4
I. 19. 29. 4·31	1. 0. 42·55	84. 2. 41·2	58. 59·1	16. 6·0	52. 41. 53·55	54. 14. 55·0	
II. 19. 30. 4·15	1. 0. 44·62	84. 2. 25·0	58. 59·1	16. 6·0	52. 41. 22·50	54. 14. 20·3	39·1
I. 19. 37. 1·43	1. 0. 59·10	84. 0. 32·0	58. 59·1	16. 6·0	54. 37. 21·75	56. 1. 36·5	
II. 19. 38. 1·27	1. 1. 1·18	84. 0. 15·8	58. 59·1	16. 6·0	54. 36. 50·55	56. 1. 1·6	39·2
—	1. 47. 43·90	69. 48. 7·8	—	—	45. 22. 3·90	42. 17. 30·5	—
—	,,	,,	—	—	47. 27. 13·65	44. 13. 11·1	—
I. 19. 28. 52·71	1. 51. 42·14	77. 42. 51·8	59. 13·2	16. 9·8	40. 53. 13·50	40. 57. 43·9	
II. 19. 29. 52·54	1. 51. 44·32	77. 42. 36·6	59. 13·2	16. 9·8	40. 52. 40·80	40. 57. 8·8	35·2
I. 19. 35. 39·88	1. 51. 56·91	77. 41. 8·3	59. 13·3	16. 9·8	42. 31. 36·30	42. 29. 33·2	
II. 19. 36. 39·72	1. 51. 59·07	77. 40. 53·1	59. 13·3	16. 9·8	42. 31. 3·90	42. 28. 58·3	31·8
I. 19. 42. 0·19	1. 52. 10·69	77. 39. 31·6	59. 13·3	16. 9·8	44. 3. 29·85	43. 55. 24·6	
II. 19. 43. 0·02	1. 52. 12·86	77. 39. 16·4	59. 13·3	16. 9·8	44. 2. 57·30	43. 54. 49·7	34·6
I. 20. 7. 14·73	1. 53. 5·66	77. 33. 7·1	59. 13·5	16. 9·9	50. 9. 25·65	49. 37. 49·6	
II. 20. 8. 14·57	1. 53. 7·83	77. 32. 51·9	59. 13·5	16. 9·9	50. 8. 53·10	49. 37. 14·7	33·7
I. 20. 14. 43·49	1. 53. 21·96	77. 31. 13·3	59. 13·6	16. 9·9	51. 57. 51·00	51. 19. 20·7	
II. 20. 15. 43·33	1. 53. 24·13	77. 30. 58·1	59. 13·6	16. 9·9	51. 57. 18·45	51. 18. 46·0	36·5
I. 20. 21. 27·72	1. 53. 36·64	77. 29. 30·8	59. 13·6	16. 9·9	53. 35. 30·45	52. 50. 46·7	
II. 20. 22. 27·55	1. 53. 38·82	77. 29. 15·6	59. 13·6	16. 9·9	53. 34. 57·75	52. 50. 11·6	33·5

January 11. Moon unsteady. Aperture reduced.

Day.	Observer.	Object.	Altazimuth-Clock Time of Vertical Transit over Mean of Horizontal Wires.	Lamp Right or Left.	Reading of Vertical Circle corrected for Runs of Micrometers.	Level Indication (additive).	Barometer and External Thermometer.	Refraction.	True observed Zenith Distance.
1875.			h m s		° ′ ″	″		″	° ′ ″
January 14	NI	β Arietis	5. 40. 56·04	L	324. 22. 21·8	74·0		77·6	54. 24. 27·0
		,, ...	5. 51. 17·96	R	213. 13. 48·3	70·6	65°·9	84·9	56. 46. 52·4
15	T	Moon's L. L. ...	4. 42. 43·34	L	298. 38. 4·0	78·2	64°·0	30·6	28. 39. 26·4
		,, ...	4. 50. 56·16	L	300. 29. 43·6	78·4	29in·85	33·0	30. 31. 8·6
		,, ...	4. 58. 29·96	L	302. 12. 30·0	78·7		35·3	32. 13. 57·6
		,, ...	6. 0. 58·88	R	223. 39. 30·0	63·8		58·6	46. 20. 51·2
		,, ...	6. 7. 19·06	R	222. 14. 4·6	63·6		61·5	47. 46. 19·7
		,, ...	6. 19. 18·36	R	219. 32. 45·5	62·6		67·6	50. 27. 45·9
16	NI	Moon's L. L. ...	6. 16. 44·68	R	234. 16. 26·2	63·4	71°·5	39·7	35. 43. 36·5
		,, ...	6. 26. 40·86	R	232. 3. 51·7	63·0		43·0	37. 56. 14·7
		,, ...	6. 45. 54·14	R	227. 48. 2·3	63·2		50·0	42. 12. 10·9
		,, ...	6. 55. 20·28	L	314. 15. 39·3	79·0	72°·1	53·8	44. 17. 25·7
		,, ...	7. 3. 30·66	L	316. 3. 48·1	79·4		57·2	46. 5. 38·3
		,, ...	7. 11. 34·62	L	317. 50. 26·9	80·2	72°·7	60·9	47. 52. 21·6
		Aldebaran......	7. 20. 35·16	L	311. 2. 28·2	81·2	29in·91	48·0	41. 4. 11·0
		,, ...	7. 28. 18·24	R	227. 8. 13·0	62·0	73°·1	51·1	42. 52. 2·5
17	NI	Moon's L. L. ...	5. 27. 42·96	R	258. 29. 47·2	66·6	68°·0	11·4	11. 29. 43·5
		,, ...	5. 38. 11·98	R	256. 22. 31·4	65·4		13·5	13. 37. 2·6
		,, ...	5. 45. 21·72	R	254. 53. 32·9	65·0		15·1	15. 6. 3·1
		,, ...	5. 55. 19·40	L	287. 10. 36·5	75·5		17·3	17. 11. 43·4

January 15 and 16. The adopted Zenith point corresponding to the mean wire is 270. 0. 26·4 (° ′ ″)
January 17. " " " 270. 0. 25·9

Greenwich Mean Solar Time, assuming the West Longitude to be I. 10h. 31m. 0s. II. 10h. 32m. 0s.	Tabular Geocentric Elements (R. A. and N. P. D. corrected). Apparent Right Ascension of Center.	Apparent North Polar Distance of Center.	Equatorial Horizontal Parallax.	Semi-diameter.	Hour-Angle.	Tabular Zenith Distance of Star or of Limb of Moon.	Inferred Longitude West of Greenwich 10h. 31m. +
h m s	h m s	° ′ ″	′ ″	′ ″	° ′ ″	° ′ ″	s
——	1. 47. 43·88	69. 48. 7·9	—	—	58. 31. 16·80	54. 24. 28·9	—
——	,,	,,	—	—	61. 6. 45·75	56. 46. 55·2	—
I. 19. 33. 16·89	2. 45. 38·74	71. 56. 41·3	59. 23·1	16. 12·6	29. 29. 26·55	28. 39. 41·4	
II. 19. 34. 16·72	2. 45. 41·05	71. 56. 28·0	59. 23·1	16. 12·6	29. 28. 51·90	28. 39. 6·5	25·8
I. 19. 41. 28·37	2. 45. 57·69	71. 54. 52·1	59. 23·1	16. 12·6	31. 27. 54·60	30. 31. 21·9	
II. 19. 42. 28·20	2. 45. 59·99	71. 54. 38·8	59. 23·1	16. 12·6	31. 27. 20·10	30. 30. 47·1	22·9
I. 19. 49. 0·93	2. 46. 15·14	71. 53. 11·6	59. 23·2	16. 12·6	33. 16. 59·85	32. 14. 10·8	
II. 19. 50. 0·76	2. 46. 17·45	71. 52. 58·4	59. 23·2	16. 12·6	33. 16. 25·20	32. 13. 35·9	22·7
I. 20. 51. 19·61	2. 48. 39·52	71. 39. 25·4	59. 23·5	16. 12·7	48. 18. 7·95	46. 21. 4·3	
II. 20. 52. 19·44	2. 48. 41·84	71. 39. 12·2	59. 23·5	16. 12·7	48. 17. 33·15	46. 20. 29·3	22·5
I. 20. 57. 38·74	2. 48. 54·19	71. 38. 2·0	59. 23·5	16. 12·7	49. 49. 30·60	47. 46. 32·8	
II. 20. 58. 38·58	2. 48. 56·51	71. 37. 48·8	59. 23·5	16. 12·7	49. 48. 55·80	47. 45. 57·5	22·3
I. 21. 9. 36·07	2. 49. 21·95	71. 35. 24·3	59. 23·5	16. 12·7	52. 42. 23·70	50. 27. 59·1	
II. 21. 10. 35·91	2. 49. 24·27	71. 35. 11·2	59. 23·5	16. 12·7	52. 41. 48·90	50. 27. 24·1	22·6
I. 21. 3. 7·52	3. 46. 43·99	66. 54. 3·9	59. 27·4	16. 13·7	37. 43. 36·90	35. 43. 49·5	
II. 21. 4. 7·35	3. 46. 46·46	66. 53. 53·7	59. 27·4	16. 13·7	37. 42. 59·85	35. 43. 14·9	22·5
I. 21. 13. 2·07	3. 47. 8·57	66. 52. 22·8	59. 27·3	16. 13·7	40. 6. 31·05	37. 56. 29·0	
II. 21. 14. 1·90	3. 47. 11·04	66. 52. 12·7	59. 27·3	16. 13·7	40. 5. 54·00	37. 55. 54·2	24·7
I. 21. 32. 12·23	3. 47. 56·14	66. 49. 8·1	59. 27·3	16. 13·7	44. 42. 57·00	42. 12. 24·9	
II. 21. 33. 12·06	3. 47. 58·62	66. 48. 58·0	59. 27·3	16. 13·7	44. 42. 19·80	42. 11. 49·8	23·9
I. 21. 41. 36·82	3. 48. 19·52	66. 47. 32·8	59. 27·3	16. 13·7	46. 58. 38·40	44. 17. 41·0	
II. 21. 42. 36·65	3. 48. 22·00	66. 47. 22·7	59. 27·3	16. 13·7	46. 58. 1·20	44. 17. 6·0	26·2
I. 21. 49. 45·87	3. 48. 39·77	66. 46. 10·4	59. 27·3	16. 13·7	48. 56. 10·50	46. 5. 59·0	
II. 21. 50. 45·70	3. 48. 42·24	66. 46. 0·3	59. 27·3	16. 13·7	48. 55. 33·45	46. 5. 23·9	35·4
I. 21. 57. 48·52	3. 48. 59·76	66. 44. 49·3	59. 27·3	16. 13·7	50. 52. 10·20	47. 52. 40·1	
II. 21. 58. 48·35	3. 49. 2·24	66. 44. 39·2	59. 27·3	16. 13·7	50. 51. 33·00	47. 52. 4·9	31·5
——	4. 28. 45·61	73. 44. 30·3	—	—	43. 10. 50·70	41. 4. 9·0	—
——	,,	,,	—	—	45. 6. 36·90	42. 51. 59·9	—
I. 20. 10. 18·58	4. 45. 40·96	63. 39. 56·8	59. 24·0	16. 12·8	10. 44. 6·60	11. 29. 54·8	
II. 20. 11. 18·42	4. 45. 43·57	63. 39. 50·4	59. 24·0	16. 12·8	10. 43. 27·45	11. 29. 24·8	22·6
I. 20. 20. 45·89	4. 46. 8·29	63. 38. 49·6	59. 23·9	16. 12·7	13. 14. 32·10	13. 37. 11·8	
II. 20. 21. 45·73	4. 46. 10·89	63. 38. 43·2	59. 23·9	16. 12·7	13. 13. 53·10	13. 36. 40·8	17·8
I. 20. 27. 54·56	4. 46. 26·95	63. 38. 3·8	59. 23·9	16. 12·7	14. 57. 18·30	15. 6. 15·1	
II. 20. 28. 54·29	4. 46. 29·56	63. 37. 57·4	59. 23·9	16. 12·7	14. 56. 39·15	15. 5. 43·7	22·9
I. 20. 37. 50·52	4. 46. 52·91	63. 37. 0·3	59. 23·8	16. 12·7	17. 20. 14·25	17. 11. 56·9	
II. 20. 38. 50·35	4. 46. 55·52	63. 36. 54·0	59. 23·8	16. 12·7	17. 19. 35·10	17. 11. 24·3	24·9

January 15. Aperture reduced. Fine limb.

Day.	Observer.	Object.	Altazimuth-Clock Time of Vertical Transit over Mean of Horizontal Wires.	Lamp Right or Left.	Reading of Circle corrected for Vertical Runs of Micrometers.	Level Indication (additive).	Barometer and External Thermometer.	Refraction.	True observed Zenith Distance.
1875.			h m s		° ′ ″	″		″	° ′ ″
January 17	NI	Moon's L. L. ...	6. 3. 38·90	L	288. 56. 43·3	77·1	30in·01	19·2	18. 57. 53·7
		,, ...	6. 11. 16·20	L	290. 34. 31·0	77·5	67°·0	21·0	20. 35. 43·6
18	NI	Moon's U. L. ...	3. 22. 31·44	L	302. 40. 34·9	65·6	67°·2	35·9	32. 41. 50·5
		,, ...	3. 30. 1·52	L	301. 4. 30·3	66·7		33·8	31. 5. 44·9
		,, ...	3. 37. 12·64	L	299. 32. 39·7	66·7		31·8	29. 33. 52·3
		,, ...	3. 44. 31·70	R	241. 59. 10·5	77·2		29·9	28. 0. 28·1
		,, ...	3. 51. 49·26	R	243. 32. 0·5	76·0	30in·11	26·7	26. 27. 36·1
		,, ...	3. 58. 25·30	R	244. 55. 46·9	74·6	64°·8	26·3	25. 3. 50·7
		γ Geminorum ...	4. 8. 54·80	R	236. 26. 56·1	72·1		37·3	33. 32. 55·0
		,, ...	4. 19. 1·48	L	301. 10. 25·9	67·4	64°·0	34·1	31. 11. 41·5
19	NI	Moon's U. L. ..	3. 38. 54·24	L	313. 28. 54·3	62·6	69°·3	53·1	43. 30. 24·1
		,, ...	3. 45. 45·08	L	312. 1. 5·6	63·2		50·5	42. 2. 33·4
		,, ...	3. 53. 56·48	L	310. 16. 1·4	63·6		47·5	40. 17. 26·6
		,, ...	4. 1. 43·76	R	231. 22. 21·1	81·8		44·8	38. 37. 27·8
		,, ...	4. 8. 30·64	R	232. 49. 26·9	81·0		42·6	37. 10. 20·6
		,, ...	4. 16. 42·72	R	234. 34. 44·4	79·7	66°·9	40·0	35. 25. 1·8
		Pollux	4. 26. 26·64	R	226. 31. 9·4	79·4	30in·20	53·3	43. 28. 50·4
		,, ...	4. 36. 47·02	L	311. 10. 56·1	62·2	66°·8	49·2	41. 12. 21·6
	T	Moon's L. L. ...	10. 52. 3·20	R	217. 38. 49·9	67·6	62°·5	73·3	52. 21. 41·7
		,, ...	10. 59. 27·66	R	216. 4. 15·0	67·0		77·5	53. 56. 21·4

January 18. The adopted Zenith point corresponding to the mean wire is 270. 0. 25·9 (° ′ ″)
January 19. ,, ,, ,, 270. 0. 25·9

Greenwich Mean Solar Time, assuming the West Longitude to be I. 10h. 31m. 0s. II. 10h. 32m. 0s.	Tabular Geocentric Elements (R. A. and N. P. D. corrected). Apparent Right Ascension of Center.	Apparent North Polar Distance of Center.	Equatorial Horizontal Parallax.	Semi-diameter.	Hour-Angle.	Tabular Zenith Distance of Star or of Limb of Moon.	Inferred Longitude West of Greenwich 10h. 31m. +
h m s	h m s	° ′ ″	′ ″	′ ″	° ′ ″	° ′ ″	s
I. 20. 46. 8·66	4. 47. 14·62	63. 36. 7·6	59. 23·8	16. 12·7	19. 19. 41·10	18. 58. 7·3	
II. 20. 47. 8·49	4. 47. 17·23	63. 36. 1·3	59. 23·8	16. 12·7	19. 19. 1·95	18. 57. 34·4	24·8
I. 20. 53. 44·71	4. 47. 34·50	63. 35. 19·5	59. 23·8	16. 12·7	21. 9. 2·40	20. 35. 57·8	
II. 20. 54. 44·54	4. 47. 37·11	63. 35. 13·2	59. 23·8	16. 12·7	21. 8. 23·25	20. 35. 24·3	25·4
I. 18. 1. 32·29	5. 43. 37·34	62. 3. 17·7	59. 13·7	16. 10·0	35. 2. 42·30	32. 41. 34·3	
II. 18. 2. 32·13	5. 43. 40·01	62. 3. 15·4	59. 13·7	16. 10·0	35. 3. 22·35	32. 42. 9·6	27·5
I. 18. 9. 1·13	5. 43. 57·37	62. 3. 0·4	59. 13·6	16. 10·0	33. 15. 11·85	31. 5. 30·1	
II. 18. 10. 0·96	5. 44. 0·04	62. 2. 58·1	59. 13·6	16. 10·0	33. 15. 51·90	31. 6. 5·6	25·0
I. 18. 16. 11·06	5. 44. 16·55	62. 2. 43·9	59. 13·6	16. 9·9	31. 32. 13·05	29. 33. 36·8	
II. 18. 17. 10·89	5. 44. 19·22	62. 2. 41·7	59. 13·6	16. 9·9	31. 32. 53·10	29. 34. 12·5	26·1
I. 18. 23. 28·89	5. 44. 36·09	62. 2. 27·3	59. 13·5	16. 9·9	29. 47. 20·55	28. 0. 12·9	
II. 18. 24. 28·73	5. 44. 38·77	62. 2. 25·1	59. 13·5	16. 9·9	29. 48. 0·75	28. 0. 48·5	25·6
I. 18. 30. 45·25	5. 44. 55·57	62. 2. 11·0	59. 13·4	16. 9·9	28. 2. 49·50	26. 27. 22·3	
II. 18. 31. 45·09	5. 44. 58·25	62. 2. 8·8	59. 13·4	16. 9·9	28. 3. 29·70	26. 27. 57·7	23·4
I. 18. 37. 20·19	5. 45. 13·18	62. 1. 56·4	59. 13·3	16. 9·9	26. 28. 13·35	25. 3. 34·9	
II. 18. 38. 20·02	5. 45. 15·87	62. 1. 54·1	59. 13·3	16. 9·9	26. 28. 53·70	25. 4. 10·7	26·5
——	6. 30. 30·54	73. 29. 39·3	—	—	35. 10. 11·55	33. 32. 50·9	—
——	,,	,,	—	—	32. 38. 31·80	31. 11. 41·8	—
I. 18. 13. 57·19	6. 48. 19·89	62. 4. 8·5	58. 53·6	16. 4·5	47. 7. 28·20	43. 30. 8·3	
II. 18. 14. 57·03	6. 48. 22·53	62. 4. 10·9	58. 53·6	16. 4·5	47. 8. 7·80	43. 30. 43·3	27·1
I. 18. 20. 46·91	6. 48. 37·99	62. 4. 24·8	58. 53·5	16. 4·5	45. 29. 17·25	42. 2. 19·6	
II. 18. 21. 46·74	6. 48. 40·63	62. 4. 27·2	58. 53·5	16. 4·5	45. 29. 56·85	42. 2. 54·8	23·5
I. 18. 28. 56·95	6. 48. 59·63	62. 4. 44·5	58. 53·4	16. 4·4	43. 31. 51·00	40. 17. 13·7	
II. 18. 29. 56·79	6. 49. 2·25	62. 4. 47·0	58. 53·4	16. 4·4	43. 32. 30·30	40. 17. 48·4	22·3
I. 18. 36. 42·94	6. 49. 20·20	62. 5. 3·5	58. 53·2	16. 4·4	41. 40. 10·50	38. 37. 13·7	
II. 18. 37. 42·78	6. 49. 22·85	62. 5. 5·9	58. 53·2	16. 4·4	41. 40. 50·25	38. 37. 48·8	24·1
I. 18. 43. 28·71	6. 49. 38·11	62. 5. 20·1	58. 53·1	16. 4·4	40. 2. 56·10	37. 10. 7·7	
II. 18. 44. 28·54	6. 49. 40·75	62. 5. 22·6	58. 53·1	16. 4·4	40. 3. 35·70	37. 10. 42·7	22·1
I. 18. 51. 39·43	6. 49. 59·78	62. 5. 40·4	58. 53·0	16. 4·3	38. 5. 20·25	35. 24. 47·6	
II. 18. 52. 39·26	6. 50. 2·42	62. 5. 42·9	58. 53·0	16. 4·3	38. 5. 59·85	35. 25. 22·5	24·4
——	7. 37. 41·34	61. 40. 21·0	—	—	47. 34. 45·00	43. 28. 54·5	—
——	,,	,,	—	—	44. 59. 39·60	41. 12. 25·6	—
I. 1. 25. 55·45	7. 7. 18·98	62. 26. 6·5	58. 45·9	16. 2·4	56. 25. 3·75	52. 21. 54·1	
II. 1. 26. 55·29	7. 7. 21·59	62. 26. 10·3	58. 45·9	16. 2·4	56. 24. 24·60	52. 21. 19·9	21·8
I. 1. 33. 18·69	7. 7. 38·34	62. 26. 34·1	58. 45·8	16. 2·3	58. 11. 20·25	53. 56. 31·6	
II. 1. 34. 18·53	7. 7. 40·96	62. 26. 37·8	58. 45·8	16. 2·3	58. 10. 40·95	53. 55. 57·4	17·9

January 18. Aperture reduced.

January 19. Aperture reduced. Pollux unsteady.

Day.	Observer.	Object.	Altazimuth-Clock Time of Vertical Transit over Mean of Horizontal Wires.	Lamp Right or Left.	Reading of Vertical Circle corrected for Runs of Micrometers.	Level Indication (additive).	Barometer and External Thermometer.	Refraction.	True observed Zenith Distance.
			h m s		° ′ ″	″		″	° ′ ″
1875. January 19	T	Moon's L. L. ...	11. 4. 40·08	R	214. 57. 53·5	66·8	30in·19	80·6	55. 2. 46·2
		,, ...	11. 9. 40·16	R	213. 54. 13·7	66·2	64°·0	83·8	56. 6. 29·8
		,, ...	11. 17. 38·14	L	327. 45. 28·2	76·9		89·3	57. 47. 48·5
		,, ...	11. 23. 47·34	L	329. 3. 32·9	77·6		93·9	59. 5. 58·5
		,, ...	11. 28. 59·28	L	330. 9. 20·8	78·4		98·1	60. 11. 51·4
		,, ...	11. 34. 14·80	L	331. 15. 48·9	79·0		102·6	61. 18. 24·6
		Pollux	11. 40. 19·28	L	325. 7. 16·0	79·1		80·8	55. 9. 30·0
		,, ...	11. 47. 41·92	L	326. 43. 39·3	79·4		85·8	56. 45. 58·6
		,, ...	11. 55. 17·96	R	211. 35. 33·2	66·4		91·4	58. 25. 17·7
		,, ...	12. 1. 44·36	R	210. 11. 43·2	65·7		96·5	59. 49. 13·5
20	T	Pollux	4. 32. 53·34	R	227. 56. 22·8	76·6	71°·0	50·5	42. 3. 37·0
		,, ...	4. 37. 58·40	R	229. 3. 29·8	76·4	30in·24	48·5	40. 56. 28·2
		,, ...	4. 44. 12·44	L	309. 32. 43·2	63·6		46·2	39. 34. 7·1
		,, ...	4. 51. 19·34	L	307. 58. 50·4	64·0		43·7	38. 0. 12·2
		Moon's U. L. ...	4. 57. 17·78	L	310. 37. 46·8	64·6		48·0	40. 39. 13·5
		, L. L. ...	4. 59. 52·72	L	*310. 36. 15·7	64·6		48·0	40. 37. 42·4
		,, U. L. ...	5. 7. 58·38	L	308. 18. 10·5	65·2		44·2	38. 19. 34·0
		,, U. L. ...	5. 14. 21·50	L	306. 54. 38·8	65·0		42·0	36. 55. 59·9
		,, L. L. ...	5. 16. 49·52	L	306. 54. 38·8	65·0		42·0	36. 55. 59·9
		,, U. L. ...	5. 22. 57·54	R	234. 56. 32·2	77·0		39·2	35. 3. 15·9
		,, U. L. ...	5. 30. 23·16	R	236. 33. 52·0	76·2		36·9	33. 25. 54·6
		,, U. L. ...	5. 39. 32·90	R	238. 34. 1·2	75·4		34·2	31. 25. 43·5

January 20. The adopted Zenith point corresponding to the mean wire is 270. 0. 25·9 (° ′ ″)

* The first wire was lost: the circle-reading has been diminished 1′. 31″·1.

Greenwich Mean Solar Time, assuming the West Longitude to be I. 10h. 31m. 0s. II. 10h. 32m. 0s.	Tabular Geocentric Elements (R. A. and N. P. D. corrected). Apparent Right Ascension of Center.	Apparent North Polar Distance of Center.	Equatorial Horizontal Parallax.	Semi-diameter.	Hour-Angle.	Tabular Zenith Distance of Star or of Limb of Moon.	Inferred Longitude West of Greenwich 10h. 31m. +
h m s	h m s	° ′ ″	′ ″	′ ″	° ′ ″	° ′ ″	s
I. 1. 38. 30·26	7. 7. 51·96	62. 26. 53·6	58. 45·7	16. 2·3	59. 26. 2·25	55. 2. 57·6	
II. 1. 39. 30·10	7. 7. 54·57	62. 26. 57·3	58. 45·7	16. 2·3	59. 25. 23·10	55. 2. 23·0	19·8
I. 1. 43. 29·52	7. 8. 5·03	62. 27. 12·3	58. 45·6	16. 2·3	60. 37. 47·40	56. 6. 40·2	
II. 1. 44. 29·36	7. 8. 7·64	62. 27. 16·1	58. 45·6	16. 2·3	60. 37. 8·25	56. 6. 6·3	18·4
I. 1. 51. 26·20	7. 8. 25·85	62. 27. 42·5	58. 45·4	16. 2·2	62. 32. 4·80	57. 47. 59·9	
II. 1. 52. 26·04	7. 8. 28·46	62. 27. 46·3	58. 45·4	16. 2·2	62. 31. 25·65	57. 47. 26·1	20·2
I. 1. 57. 34·40	7. 8. 41·92	62. 28. 5·8	58. 45·3	16. 2·2	64. 0. 21·90	59. 6. 7·5	
II. 1. 58. 34·24	7. 8. 44·54	62. 28. 9·6	58. 45·3	16. 2·2	63. 59. 42·60	59. 5. 33·6	15·9
I. 2. 2. 45·49	7. 8. 55·51	62. 28. 25·7	58. 45·2	16. 2·2	65. 14. 57·15	60. 12. 1·3	
II. 2. 3. 45·33	7. 8. 58·12	62. 28. 29·5	58. 45·2	16. 2·2	65. 14. 18·00	60. 11. 27·7	17·7
I. 2. 8. 0·15	7. 9. 9·24	62. 28. 45·8	58. 45·1	16. 2·1	66. 30. 24·00	61. 18. 34·2	
II. 2. 8. 59·98	7. 9. 11·85	62. 28. 49·6	58. 45·1	16. 2·1	66. 29. 44·85	61. 18. 0·7	17·2
—	7. 37. 41·33	61. 40. 20·8	—	—	60. 53. 29·85	55. 9. 27·5	—
—	,,	,,	—	—	62. 44. 9·45	56. 45. 59·3	—
—	,,	,,	—	—	64. 38. 10·05	58. 25. 15·6	—
—	,,	,,	—	—	66. 14. 46·05	59. 49. 13·1	—
—	7. 37. 41·35	61. 40. 21·0	—	—	45. 57. 49·20	42. 3. 36·7	—
—	,,	,,	—	—	44. 41. 33·15	40. 56. 29·0	—
—	,,	,,	—	—	43. 8. 2·55	39. 34. 10·5	—
—	,,	,,	—	—	41. 21. 18·90	38. 0. 14·0	—
I. 19. 28. 12·96	7. 53. 44·25	64. 1. 47·8	58. 23·4	15. 56·2	43. 52. 25·80	40. 39. 1·5	
II. 19. 29. 12·80	7. 53. 46·76	64. 1. 54·6	58. 23·4	15. 56·2	43. 53. 3·45	40. 39. 35·8	21·0
I. 19. 30. 47·49	7. 53. 50·73	64. 2. 5·4	58. 23·3	15. 56·2	43. 15. 18·75	40. 37. 33·6	
II. 19. 31. 47·33	7. 53. 53·24	64. 2. 12·2	58. 23·3	15. 56·2	43. 15. 56·40	40. 38. 7·6	15·3
I. 19. 38. 51·82	7. 54. 11·05	64. 3. 0·6	58. 23·1	15. 56·1	41. 18. 58·65	38. 19. 24·0	
II. 19. 39. 51·66	7. 54. 13·57	64. 3. 7·4	58. 23·1	15. 56·1	41. 19. 36·45	38. 19. 58·3	17·8
I. 19. 45. 13·90	7. 54. 27·08	64. 3. 44·2	58. 23·0	15. 56·1	39. 47. 12·15	36. 55. 48·0	
II. 19. 46. 13·74	7. 54. 29·59	64. 3. 51·0	58. 23·0	15. 56·1	39. 47. 49·80	36. 56. 22·1	20·9
I. 19. 47. 41·52	7. 54. 33·27	64. 4. 1·1	58. 22·9	15. 56·1	39. 11. 44·70	36. 55. 47·7	
II. 19. 48. 41·35	7. 54. 35·78	64. 4. 7·9	58. 22·9	15. 56·1	39. 12. 22·35	36. 56. 21·6	21·6
I. 19. 53. 48·54	7. 54. 48·66	64. 4. 43·1	58. 22·8	15. 56·1	37. 43. 35·10	35. 3. 6·5	
II. 19. 54. 48·38	7. 54. 51·17	64. 4. 50·0	58. 22·8	15. 56·1	37. 44. 12·75	35. 3. 40·5	16·5
I. 20. 1. 12·94	7. 55. 7·29	64. 5. 34·1	58. 22·6	15. 56·0	35. 56. 50·25	33. 25. 43·8	
II. 20. 2. 12·78	7. 55. 9·80	64. 5. 41·1	58. 22·6	15. 56·0	35. 57. 27·90	33. 26. 17·7	19·1
I. 20. 10. 21·20	7. 55. 30·26	64. 6. 37·4	58. 22·4	15. 56·0	33. 45. 8·55	31. 25. 32·4	
II. 20. 11. 21·03	7. 55. 32·76	64. 6. 44·3	58. 22·4	15. 56·0	33. 45. 46·05	31. 26. 5·8	19·9

January 20. Aperture reduced. Pollux unsteady. Moon in cloud. Full moon occurred at 15h. 12m·1. Honolulu Sidereal Time. The observations of ☽ L. L. by T have not been used.

Day.	Observer.	Object.	Altazimuth-Clock Time of Vertical Transit over Mean of Horizontal Wires.	Lamp Right or Left.	Reading of Vertical Circle corrected for Runs of Micrometers.	Level Indication (additive).	Barometer and External Thermometer.	Refraction.	True observed Zenith Distance.
			h m s		° ′ ″	″		″	° ′ ″
1875. January 20	T	Moon's U. L. ...	5. 46. 13·36	R	240. 1. 33·8	75·3	30in·25	32·3	29. 58. 9·1
		,, L. L. ...	5. 48. 41·30	R	240. 1. 33·8	75·3	71°·0	32·3	29. 58. 9·1
	NI	,, L. L. ...	9. 37. 24·36	R	247. 39. 47·8	65·2	70°·1	23·0	22. 19. 55·9
		,, U. L. ...	9. 39. 52·08	R	247. 39. 47·8	65·2		23·0	22. 19. 55·9
		,, L. L. ...	10. 3. 9·74	R	242. 1. 14·8	64·6		29·7	27. 58. 36·2
		,, U. L. ...	10. 5. 37·02	R	242. 1. 14·8	64·0		29·7	27. 58. 36·8
		,, L. L. ...	10. 14. 31·34	R	239. 31. 34·0	63·9	68°·2	33·0	30. 28. 21·0
		,, U. L. ...	10. 16. 58·36	R	239. 31. 34·0	63·6		33·0	30. 28. 21·3
		,, L. L. ...	10. 27. 39·90	L	303. 20. 11·7	76·0		37·0	33. 21. 38·8
		,, U. L. ...	10. 30. 6·90	L	303. 20. 11·7	76·0		37·0	33. 21. 38·8
		,, L. L. ...	10. 39. 22·58	L	305. 54. 30·2	77·6		40·7	35. 56. 2·6
		,, U. L. ...	10. 41. 49·45	L	305. 54. 30·2	78·0	30in·22	40·7	35. 56. 3·0
		,, L. L. ...	10. 51. 13·52	L	308. 30. 39·0	78·2	67°·0	44·7	38. 32. 16·0
		,, U. L. ...	10. 53. 40·38	L	308. 30. 39·0	78·6		44·7	38. 32. 16·4
		Pollux	11. 6. 22·78	L	317. 41. 53·4	78·6		61·7	47. 43. 47·8
		,, ...	11. 14. 26·04	R	220. 30. 34·9	68·0		65·7	49. 29. 48·7
21	T	Moon's U. L. ...	5. 41. 53·26	L	314. 28. 47·9	70·6	70°·0	55·0	44. 30. 27·6
		,, L. L. ...	5. 44. 16·24	L	314. 28. 47·9	70·6	30in·26	55·0	44. 30. 27·6
		,, U. L. ...	5. 50. 0·28	L	312. 40. 31·9	70·6		51·7	42. 42. 8·3

January 21. The adopted Zenith point corresponding to the mean wire is 270. 0. 25·9 (° ′ ″)

Greenwich Mean Solar Time, assuming the West Longitude to be I. 10h. 31m. 0s. II. 10h. 31m. 0s.	Tabular Geocentric Elements (R. A. and N. P. D. corrected). Apparent Right Ascension of Center.	Apparent North Polar Distance of Center.	Equatorial Horizontal Parallax.	Semi-diameter.	Hour-Angle.	Tabular Zenith Distance of Star or of Limb of Moon.	Inferred Longitude West of Greenwich 10h. 31m. +
h m s	h m s	° ′ ″	′ ″	′ ″	° ′ ″	° ′ ″	s
I. 20. 17. 0·57	7. 55. 46·98	64. 7. 23·5	58. 22·3	15. 55·9	32. 9. 12·30	29. 57. 57·6	
II. 20. 18. 0·41	7. 55. 49·49	64. 7. 30·5	58. 22·3	15. 55·9	32. 9. 49·95	29. 58. 31·2	20·5
I. 20. 19. 28·11	7. 55. 53·17	64. 7. 40·6	58. 22·2	15. 55·9	31. 33. 46·05	29. 57. 57·1	
II. 20. 20. 27·95	7. 55. 55·67	64. 7. 47·6	58. 22·2	15. 55·9	31. 34. 23·55	29. 58. 30·5	21·6
I. 0. 7. 33·92	8. 5. 23·16	64. 35. 12·2	58. 16·9	15. 54·5	23. 14. 33·30	22. 20. 8·5	
II. 0. 8. 33·75	8. 5. 25·64	64. 35. 19·7	58. 16·9	15. 54·5	23. 13. 56·10	22. 19. 34·6	22·3
I. 0. 10. 1·24	8. 5. 29·26	64. 35. 30·7	58. 16·9	15. 54·5	23. 49. 57·60	22. 20. 5·9	
II. 0. 11. 1·07	8. 5. 31·74	64. 35. 38·2	58. 16·9	15. 54·5	23. 49. 20·40	22. 19. 31·9	17·7
I. 0. 33. 15·09	8. 6. 26·96	64. 38. 26·6	58. 16·3	15. 54·3	29. 24. 57·15	27. 58. 46·6	
II. 0. 34. 14·92	8. 6. 29·43	64. 38. 34·2	58. 16·3	15. 54·3	29. 24. 20·10	27. 58. 12·7	18·4
I. 0. 35. 41·97	8. 6. 33·03	64. 38. 45·2	58. 16·3	15. 54·3	30. 0. 15·30	27. 58. 50·1	
II. 0. 36. 41·80	8. 6. 35·51	64. 38. 52·8	58. 16·3	15. 54·3	29. 59. 38·10	27. 58. 16·0	23·4
I. 0. 44. 34·82	8. 6. 55·08	64. 39. 52·9	58. 16·1	15. 54·2	32. 8. 19·35	30. 28. 30·7	
II. 0. 45. 34·66	8. 6. 57·55	64. 40. 0·5	58. 16·1	15. 54·2	32. 7. 42·30	30. 27. 56·9	17·2
I. 0. 47. 1·45	8. 7. 1·14	64. 40. 11·5	58. 16·0	15. 54·2	32. 43. 33·75	30. 28. 32·7	
II. 0. 48. 1·28	8. 7. 3·61	64. 40. 19·0	58. 16·0	15. 54·2	32. 42. 56·70	30. 27. 59·4	20·5
I. 0. 57. 41·24	8. 7. 27·59	64. 41. 33·1	58. 15·7	15. 54·1	35. 17. 20·25	33. 21. 50·0	
II. 0. 58. 41·08	8. 7. 30·06	64. 41. 40·7	58. 15·7	15. 54·1	35. 16. 43·20	33. 21. 16·5	20·1
I. 1. 0. 7·84	8. 7. 33·64	64. 41. 51·8	58. 15·7	15. 54·1	35. 52. 34·50	33. 21. 53·5	
II. 1. 1. 7·68	8. 7. 36·12	64. 41. 59·5	58. 15·7	15. 54·1	35. 51. 57·30	33. 21. 20·0	26·3
I. 1. 9. 22·00	8. 7. 56·53	64. 43. 2·7	58. 15·5	15. 54·1	38. 5. 46·35	35. 56. 16·2	
II. 1. 10. 21·83	8. 7. 59·01	64. 43. 10·4	58. 15·5	15. 54·1	38. 5. 9·15	35. 55. 42·8	24·4
I. 1. 11. 48·48	8. 8. 2·59	64. 43. 21·5	58. 15·4	15. 54·0	38. 40. 58·65	35. 56. 18·1	
II. 1. 12. 48·32	8. 8. 5·06	64. 43. 29·2	58. 15·4	15. 54·0	38. 40. 21·60	35. 55. 44·7	27·1
I. 1. 21. 11·01	8. 8. 25·81	64. 44. 33·8	58. 15·2	15. 54·0	40. 56. 11·40	38. 32. 25·8	
II. 1. 22. 10·85	8. 8. 28·28	64. 44. 41·5	58. 15·2	15. 54·0	40. 55. 34·35	38. 31. 52·6	17·7
I. 1. 23. 37·47	8. 8. 31·86	64. 44. 52·6	58. 15·1	15. 54·0	41. 31. 23·55	38. 32. 26·7	
II. 1. 24. 37·31	8. 8. 34·33	64. 45. 0·3	58. 15·1	15. 54·0	41. 30. 46·50	38. 31. 53·7	18·5
——	7. 37. 41·34	61. 40. 20·8	—	—	52. 24. 37·35	47. 43. 44·4	—
——	,,	,,	—	—	54. 25. 26·25	49. 29. 47·2	—
I. 20. 8. 46·46	8. 53. 37·98	67. 34. 5·0	57. 46·4	15. 46·1	47. 41. 40·80	44. 30. 3·4	
II. 20. 9. 46·30	8. 53. 40·31	67. 34. 15·2	57. 46·4	15. 46·1	47. 42. 15·75	44. 30. 36·9	43·3
I. 20. 11. 9·05	8. 53. 43·52	67. 34. 29·3	57. 46·3	15. 46·1	47. 7. 19·20	44. 30. 11·2	
II. 20. 12. 8·89	8. 53. 45·85	67. 34. 39·5	57. 46·3	15. 46·1	47. 7. 54·15	44. 30. 44·6	29·5
I. 20. 16. 52·15	8. 53. 56·85	67. 35. 27·7	57. 46·2	15. 46·1	45. 44. 38·55	42. 41. 43·1	
II. 20. 17. 51·99	8. 53. 59·18	67. 35. 38·0	57. 46·2	15. 46·1	45. 45. 13·50	42. 42. 16·5	45·3

January 21. Aperture reduced. The observations of ☽ U. L. have not been used.

Day.	Observer.	Object.	Altazimuth-Clock Time of Vertical Transit over Mean of Horizontal Wires.	Lamp Right or Left.	Reading of Vertical Circle corrected for Runs of Micrometers.	Level Indication (additive).	Barometer and External Thermometer.	Refraction.	True observed Zenith Distance.
1875.			h m s		° ′ ″	″		″	° ′ ″
January 21	T	Moon's L. L. ...	5. 52. 23·04	L	312. 40. 31·9	70·8		51·7	42. 42. 8·5
		,, U. L. ...	5. 57. 9·34	L	311. 4. 58·8	70·9		48·9	41. 6. 32·7
		,, L. L. ...	5. 59. 31·82	L	311. 4. 58·8	71·0		48·9	41. 6. 32·8
		,, U. L. ...	6. 8. 39·38	R	231. 27. 26·3	73·5		44·6	38. 32. 30·7
		,, U. L. ...	6. 14. 40·70	R	232. 48. 10·4	72·8		42·5	37. 11. 45·2
		,, L. L. ...	6. 17. 2·68	R	232. 48. 10·4	72·8		42·5	37. 11. 45·2
		,, U. L. ...	6. 22. 30·58	R	234. 33. 21·9	72·6		39·9	35. 26. 31·3
		,, L. L. ...	6. 24. 52·32	R	234. 33. 21·9	72·4		39·9	35. 26. 31·5
		,, U. L. ...	6. 29. 49·76	R	236. 11. 46·0	72·4		37·5	33. 48. 5·0
		,, L. L. ...	6. 32. 11·48	R	236. 11. 46·0	72·4		37·5	33. 48. 5·0
		Regulus	6. 38. 35·74	R	221. 4. 34·0	71·2		64·3	48. 55. 45·0
		,, ...	6. 45. 3·46	R	222. 34. 47·8	71·2		61·0	47. 25. 27·9
		,, ...	6. 52. 26·92	L	315. 40. 37·5	69·6	30in·26	57·4	45. 42. 18·6
		,, ...	6. 57. 33·44	L	314. 29. 24·6	70·6	69°·3	55·1	44. 31. 4·4
22	T	Moon's L. L. ...	8. 11. 36·78	L	294. 30. 44·1	70·6		25·5	24. 31. 54·3
		,, ...	8. 16. 42·68	L	293. 21. 30·1	71·0		24·1	23. 22. 38·3
		,, ...	8. 20. 39·68	L	292. 27. 57·7	71·0		23·1	22. 29. 5·9
		,, ...	8. 25. 18·68	R	248. 33. 28·7	71·6	71°·5	21·9	21. 26. 7·5
		,, ...	8. 30. 9·20	R	249. 38. 53·7	70·6		20·7	20. 20. 42·3
		,, ...	8. 34. 37·96	R	250. 39. 16·4	70·6		19·6	19. 20. 18·5

January 22. The adopted Zenith point corresponding to the mean wire is 270° 0′ 25″·9

Greenwich Mean Solar Time, assuming the West Longitude to be I. 10h. 31m. 0s. II. 10h. 32m. 0s.	Tabular Geocentric Elements (R. A. and N. P. D. corrected). Apparent Right Ascension of Center.	Apparent North Polar Distance of Center.	Equatorial Horizontal Parallax.	Semi-diameter.	Hour-Angle.	Tabular Zenith Distance of Star or of Limb of Moon.	Inferred Longitude West of Greenwich 10h. 31m. +
h m s	h m s	° ′ ″	′ ″	′ ″	° ′ ″	° ′ ″	s
I. 20. 19. 14·52	8. 54. 2·39	67. 35. 52·0	57. 46·1	15. 46·1	45. 10. 20·25	42. 41. 51·3	
II. 20. 20. 14·35	8. 54. 4·71	67. 36. 2·3	57. 46·1	15. 46·1	45. 10. 55·05	42. 42. 24·7	30·9
I. 20. 24. 0·04	8. 54. 13·47	67. 36. 40·8	57. 46·0	15. 46·0	44. 1. 31·95	41. 6. 7·2	
II. 20. 24. 59·88	8. 54. 15·80	67. 36. 51·0	57. 46·0	15. 46·0	44. 2. 6·90	41. 6. 40·4	46·1
I. 20. 26. 22·13	8. 54. 18·99	67. 37. 5·0	57. 45·9	15. 46·0	43. 27. 17·55	41. 6. 16·7	
II. 20. 27. 21·97	8. 54. 21·31	67. 37. 15·3	57. 45·9	15. 46·0	43. 27. 52·35	41. 6. 50·0	29·0
I. 20. 35. 28·21	8. 54. 40·18	67. 38. 38·4	57. 45·6	15. 45·9	41. 15. 41·85	38. 32. 4·9	
II. 20. 36. 28·04	8. 54. 42·50	67. 38. 48·7	57. 45·6	15. 45·9	41. 16. 16·65	38. 32. 38·0	46·8
I. 20. 41. 28·54	8. 54. 54·16	67. 39. 40·1	57. 45·5	15. 45·9	39. 48. 51·60	37. 11. 17·5	
II. 20. 42. 28·38	8. 54. 56·50	67. 39. 50·4	57. 45·5	15. 45·9	39. 49. 26·70	37. 11. 50·9	50·1
I. 20. 43. 50·14	8. 54. 59·65	67. 40. 4·4	57. 45·4	15. 45·9	39. 14. 44·25	37. 11. 28·7	
II. 20. 44. 49·98	8. 55. 1·97	67. 40. 14·7	57. 45·4	15. 45·9	39. 15. 19·05	37. 12. 1·8	29·9
I. 20. 49. 17·14	8. 55. 12·33	67. 41. 0·5	57. 45·3	15. 45·8	37. 55. 55·95	35. 26. 5·8	
II. 20. 50. 16·98	8. 55. 14·65	67. 41. 10·8	57. 45·3	15. 45·8	37. 56. 30·75	35. 26. 38·9	46·2
I. 20. 51. 38·50	8. 55. 17·82	67. 41. 24·8	57. 45·2	15. 45·8	37. 21. 52·20	35. 26. 18·1	
II. 20. 52. 38·33	8. 55. 20·14	67. 41. 35·0	57. 45·2	15. 45·8	37. 22. 27·00	35. 26. 51·2	24·3
I. 20. 56. 44·97	8. 55. 29·69	67. 42. 17·4	57. 45·1	15. 45·8	36. 10. 28·50	33. 47. 44·4	
II. 20. 57. 44·80	8. 55. 32·01	67. 42. 27·7	57. 45·1	15. 45·8	36. 11. 3·30	33. 48. 17·1	37·8
I. 20. 58. 56·46	8. 55. 34·79	67. 42. 40·0	57. 45·0	15. 45·8	35. 36. 19·20	33. 47. 49·4	
II. 20. 59. 56·30	8. 55. 37·11	67. 42. 50·3	57. 45·0	15. 45·8	35. 36. 54·00	33. 48. 22·3	28·5
——	10. 1. 43·93	77. 25. 23·1	—	—	50. 32. 32·40	48. 55. 46·2	—
——	,,	,,	—	—	48. 55. 36·60	47. 25. 30·9	—
——	,,	,,	—	—	47. 4. 44·55	45. 42. 20·1	—
——	,,	,,	—	—	45. 48. 6·60	44. 31. 3·6	—
I. 22. 34. 10·91	9. 52. 30·63	72. 39. 13·8	57. 1·8	15. 34·0	24. 58. 37·20	24. 31. 34·1	
II. 22. 35. 10·74	9. 52. 32·75	72. 39. 26·5	57. 1·8	15. 34·0	24. 59. 9·00	24. 32. 6·8	37·1
I. 22. 39. 16·01	9. 52. 41·44	72. 40. 18·3	57. 1·6	15. 33·9	23. 44. 50·70	23. 22. 21·3	
II. 22. 40. 15·84	9. 52. 43·57	72. 40. 30·9	57. 1·6	15. 33·9	23. 45. 22·65	23. 22. 53·6	31·6
I. 22. 43. 12·33	9. 52. 49·83	72. 41. 8·3	57. 1·5	15. 33·9	22. 47. 41·55	22. 28. 48·2	
II. 22. 44. 12·17	9. 52. 51·95	72. 41. 20·9	57. 1·5	15. 33·9	22. 48. 13·35	22. 29. 20·9	32·5
I. 22. 47. 50·57	9. 52. 59·69	72. 42. 7·2	57. 1·4	15. 33·9	21. 40. 24·45	21. 25. 50·7	
II. 22. 48. 50·41	9. 53. 1·81	72. 42. 19·8	57. 1·4	15. 33·9	21. 40. 56·25	21. 26. 23·5	30·7
I. 22. 52. 40·29	9. 53. 9·97	72. 43. 8·5	57. 1·3	15. 33·8	20. 30. 20·85	20. 20. 24·5	
II. 22. 53. 40·13	9. 53. 12·09	72. 43. 21·1	57. 1·3	15. 33·8	20. 30. 52·65	20. 20. 57·0	32·9
I. 22. 57. 8·34	9. 53. 19·46	72. 44. 5·2	57. 1·1	15. 33·8	19. 25. 31·65	19. 20. 0·0	
II. 22. 58. 8·17	9. 53. 21·58	72. 44. 17·9	57. 1·1	15. 33·8	19. 26. 3·45	19. 20. 32·7	33·9

January 22. Aperture reduced.

Day.	Observer.	Object.	Altazimuth-Clock Time of Vertical Transit over Mean of Horizontal Wires.	Lamp Right or Left.	Reading of Vertical Circle corrected for Runs of Micrometers.	Level Indication (additive).	Barometer and External Thermometer.	Refraction.	True observed Zenith Distance.
1875.			h m s		° ′ ″	″		″	° ′ ″
January 22	T	β Leonis	8. 44. 41·44	R	227. 41. 3·0	70·6		50·8	42. 19. 3·1
		,, ...	8. 50. 41·96	R	229. 4. 59·2	71·2		48·3	40. 55. 3·8
		,, ...	9. 5. 19·88	L	307. 29. 11·5	71·8	30in·20	42·8	37. 30. 40·2
		,, ...	9. 11. 23·78	L	306. 4. 36·6	72·0	71°·3	40·7	36. 6. 3·4
23	NI	Moon's L. L. ...	6. 11. 24·82	L	334. 41. 18·0	76·3	65°·3	118·2	64. 44. 3·6
		,, ...	6. 19. 44·94	L	332. 48. 45·3	76·6		109·0	62. 51. 22·0
		,, ...	6. 27. 21·96	L	331. 5. 48·7	77·0		101·5	61. 8. 18·3
		,, ...	6. 37. 16·80	R	211. 6. 54·5	66·0	64°·6	92·9	58. 54. 0·7
		,, ...	6. 44. 29·22	R	212. 44. 33·3	65·8	30in·14	87·2	57. 16. 17·0
		,, ...	6. 53. 27·88	R	214. 46. 14·2	64·8	64°·0	80·9	55. 14. 30·8
		δ Leonis	7. 4. 55·26	R	214. 6. 40·3	64·4		82·9	55. 54. 7·1
		,, ...	7. 15. 25·86	L	323. 28. 9·1	75·6		75·9	53. 30. 11·7
24	NI	Moon's L. L. ...	7. 40. 58·48	L	327. 9. 7·2	79·0	60°·6	87·6	57. 11. 24·9
		,, ...	7. 53. 31·04	L	324. 20. 25·8	80·4		78·9	54. 22. 36·2
		,, ...	8. 1. 50·46	L	322. 28. 43·5	80·6		73·8	52. 30. 49·0
		β Leonis	8. 10. 10·28	L	320. 18. 49·4	81·2	59°·4	68·4	50. 20. 50·1
		,, ...	8. 18. 51·16	R	221. 40. 51·5	66·5		63·7	48. 19. 34·6
		Moon's L. L. ...	8. 27. 39·60	R	223. 14. 12·6	65·1		60·3	46. 46. 11·5
		,, ...	8. 37. 33·40	R	225. 25. 9·5	64·7	30in·11	55·9	44. 35. 10·6
		,, ...	8. 46. 25·68	R	227. 21. 48·9	64·3	59°·3	52·2	42. 38. 27·9
25	NI	Moon's L. L. ...	8. 31. 47·24	R	211. 42. 31·8	66·6	66°·9	90·5	58. 18. 21·0

January 23 and 24. The adopted Zenith point corresponding to the mean wire is 270. 0. 28·9 (° ′ ″)

Greenwich Mean Solar Time, assuming the West Longitude to be I. 10h. 31m. 0s. II. 10h. 32m. 0s.	Tabular Geocentric Elements (R. A. and N. P. D. corrected). Apparent Right Ascension of Center.	Apparent North Polar Distance of Center.	Equatorial Horizontal Parallax.	Semi-diameter.	Hour-Angle.	Tabular Zenith Distance of Star or of Limb of Moon.	Inferred Longitude West of Greenwich 10h. 31m. +
h m s	h m s	° ′ ″	′ ″	′ ″	° ′ ″	° ′ ″	s
——	11. 42. 41·78	74. 43. 52·7	—	—	44. 15. 14·25	42. 19. 0·9	—
——	,,	,,	—	—	42. 45. 6·45	40. 55. 2·3	—
——	,,	,,	—	—	39. 5. 37·50	37. 30. 39·7	—
——	,,	,,	—	—	37. 34. 39·00	36. 6. 0·2	—
I. 20. 30. 23·90	10. 37. 34·40	77. 31. 52·9	56. 23·7	15. 23·5	66. 17. 15·60	64. 43. 47·6	
II. 20. 31. 23·73	10. 37. 36·38	77. 32. 6·7	56. 23·7	15. 23·5	66. 17. 45·30	64. 44. 19·4	30·2
I. 20. 38. 42·66	10. 37. 50·91	77. 33. 48·3	56. 23·4	15. 23·5	64. 16. 21·30	62. 51. 6·6	
II. 20. 39. 42·50	10. 37. 52·88	77. 34. 2·2	56. 23·4	15. 23·5	64. 16. 50·85	62. 51. 38·3	29·2
I. 20. 46. 18·43	10. 38. 5·98	77. 35. 33·9	56. 23·2	15. 23·4	62. 25. 52·05	61. 8. 1·0	
II. 20. 47. 18·27	10. 38. 7·96	77. 35. 47·7	56. 23·2	15. 23·4	62. 26. 21·75	61. 8. 32·9	32·5
I. 20. 56. 11·66	10. 38. 25·59	77. 37. 51·3	56. 22·9	15. 23·3	60. 2. 3·45	58. 53. 41·7	
II. 20. 57. 11·49	10. 38. 27·57	77. 38. 5·2	56. 22·9	15. 23·3	60. 2. 33·15	58. 54. 13·6	35·7
I. 21. 3. 22·91	10. 38. 39·85	77. 39. 31·2	56. 22·7	15. 23·3	58. 17. 30·90	57. 15. 57·9	
II. 21. 4. 22·75	10. 38. 41·82	77. 39. 45·1	56. 22·7	15. 23·3	58. 18. 0·45	57. 16. 29·7	36·0
I. 21. 12. 20·09	10. 38. 57·59	77. 41. 35·8	56. 22·5	15. 23·2	56. 7. 17·10	55. 14. 8·7	
II. 21. 13. 19·93	10. 38. 59·57	77. 41. 49·7	56. 22·5	15. 23·2	56. 7. 46·80	55. 14. 40·0	42·4
——	11. 7. 28·62	68. 47. 37·3	—	—	60. 23. 11·70	55. 54. 7·1	—
——	,,	,,	—	—	57. 45. 32·55	53. 30. 11·7	—
I. 21. 55. 48·02	11. 26. 25·17	83. 34. 21·9	55. 41·7	15. 12·1	56. 6. 16·50	57. 11. 8·2	
II. 21. 56. 47·86	11. 26. 27·03	83. 34. 36·3	55. 41·7	15. 12·1	56. 6. 44·40	57. 11. 39·3	32·2
I. 22. 8. 18·52	11. 26. 48·50	83. 37. 23·4	55. 41·4	15. 12·0	53. 3. 58·05	54. 22. 16·5	
II. 22. 9. 18·36	11. 26. 50·36	83. 37. 37·8	55. 41·4	15. 12·0	53. 4. 25·95	54. 22. 47·5	38·1
I. 22. 16. 36·58	11. 27. 3·97	83. 39. 23·8	55. 41·2	15. 11·9	51. 2. 58·80	52. 30. 29·7	
II. 22. 17. 36·42	11. 27. 5·83	83. 39. 38·3	55. 41·2	15. 11·9	51. 3. 26·70	52. 31. 0·7	37·1
——	11. 42. 41·83	74. 43. 52·9	—	—	52. 52. 29·25	50. 20. 48·1	—
——	,,	,,	—	—	50. 42. 16·05	48. 19. 33·6	—
I. 22. 42. 21·50	11. 27. 51·95	83. 45. 37·6	55. 40·5	15. 11·7	44. 47. 41·25	46. 45. 49·6	
II. 22. 43. 21·34	11. 27. 53·81	83. 45. 52·0	55. 40·5	15. 11·7	44. 48. 9·15	46. 46. 20·7	42·2
I. 22. 52. 13·68	11. 28. 10·34	83. 48. 0·9	55. 40·2	15. 11·7	42. 23. 50·10	44. 34. 49·5	
II. 22. 53. 13·51	11. 28. 12·20	83. 48. 15·3	55. 40·2	15. 11·7	42. 24. 18·00	44. 35. 20·7	40·6
I. 23. 1. 4·50	11. 28. 26·81	83. 50. 9·3	55. 40·0	15. 11·6	40. 14. 52·95	42. 38. 5·2	
II. 23. 2. 4·34	11. 28. 28·67	83. 50. 23·8	55. 40·0	15. 11·6	40. 15. 20·85	42. 38. 37·6	42·0
I. 22. 42. 33·28	12. 11. 43·47	89. 34. 52·5	55. 6·3	15. 2·5	54. 43. 28·50	58. 18. 0·3	
II. 22. 43. 33·11	12. 11. 45·26	89. 35. 6·9	55. 6·3	15. 2·5	54. 43. 55·35	58. 18. 30·8	40·7

January 23. Aperture reduced.

Day.	Observer.	Object.	Altazimuth-Clock Time of Vertical Transit over Mean of Horizontal Wires.	Lamp Right or Left.	Reading of Vertical Circle corrected for Runs of Micrometers.	Level Indication (additive).	Barometer and External Thermometer.	Refraction.	True observed Zenith Distance.
1875.			h m s		° ′ ″	″		″	° ′ ″
January 25	NI	Moon's L. L. ...	8. 40. 15·98	R	213. 33. 47·7	65·8		84·3	56. 26. 59·7
		,, ...	8. 49. 39·74	R	215. 36. 28·2	66·0		78·1	54. 24. 12·8
		,, ...	8. 59. 46·92	L	322. 10. 50·1	75·8	67°·3	72·1	52. 12. 49·1
		,, ...	9. 8. 30·70	L	320. 18. 28·4	76·6	30in·16	67·4	50. 20. 23·5
		,, ...	9. 17. 31·04	L	318. 23. 31·9	77·0	67°·9	63·0	48. 25. 23·0
		Spica	9. 31. 56·40	L	333. 48. 48·4	77·6		113·4	63. 51. 30·5
		,, ...	9. 40. 54·16	R	208. 3. 18·5	67·0	67°·9	104·6	61. 57. 48·0
27	NI	Spica	9. 13. 34·78	L	337. 44. 10·4	83·1		136·4	67. 47. 21·0
		,, ...	9. 21. 28·24	L	336. 2. 18·2	83·0		125·7	66. 5. 18·0
		,, ...	9. 29. 43·58	R	205. 42. 5·6	60·0		116·0	64. 19. 19·3
		,, ...	9. 37. 39·34	R	207. 22. 48·7	59·6	65°·4	107·9	62. 38. 28·5
		Moon's L. L. ...	9. 46. 40·46	R	203. 30. 38·1	59·6		128·9	66. 31. 0·1
		,, ...	9. 55. 1·14	R	205. 13. 16·9	58·8		119·2	64. 48. 12·4
		,, ...	10. 2. 27·62	R	206. 44 2·4	58·4	64°·9	111·6	63. 17. 19·7
		,, ...	10. 10. 4·64	L	331. 42. 26·4	81·0		104·6	61. 45. 3·1
		,, ...	10. 18. 38·40	L	330. 0. 2·0	81·5	30in·13	97·0	60. 2. 31·6
		,, ...	10. 26. 26·08	L	328. 27. 55·6	82·2	65°·9	91·2	58. 30. 20·1
February 5	T	δ Leonis	7. 58. 38·10	L	313. 31. 24·4	87·7	59°·1	53·8	43. 33. 20·5
		,, ...	8. 6. 10·90	R	228. 11. 19·8	58·1	30in·00	50·6	41. 48. 58·1
		α Orionis.......	9. 30. 10·84	L	325. 26. 6·8	59·8		82·2	55. 28. 3·4
		,, ...	9. 37. 20·32	R	212. 52. 47·2	87·8	58°·0	87·5	57. 7. 37·9

January 27. The adopted Zenith point corresponding to the mean wire is 270. 0. 28·9 (° ′ ″)
February 5, 270°. 0′. 25″·4. The two stars were observed for clock-error; the hour-angles have been computed from the observed zenith-distances.

Greenwich Mean Solar Time, assuming the West Longitude to be I. 10h. 31m. 0s. II. 10h. 32m. 0s.	Tabular Geocentric Elements (R. A. and N. P. D. corrected). Apparent Right Ascension of Center.	Apparent North Polar Distance of Center.	Equatorial Horizontal Parallax.	Semi-diameter.	Hour-Angle.	Tabular Zenith Distance of Star or of Limb of Moon.	Inferred Longitude West of Greenwich 10h. 31m. +
h m s	h m s	° ′ ″	′ ″	′ ″	° ′ ″	° ′ ″	s
I. 22. 51. 0·64	12. 11. 58·68	89. 36. 55·1	55. 6·1	15. 2·4	52. 40. 5·40	56. 26. 37·7	
II. 22. 52. 0·48	12. 12. 0·47	89. 37. 9·5	55. 6·1	15. 2·4	52. 40. 32·25	56. 27. 8·1	43·4
I. 23. 0. 23·11	12. 12. 15·54	89. 39. 11·0	55. 5·9	15. 2·3	50. 23. 21·75	54. 23. 52·4	
II. 23. 1. 22·95	12. 12. 17·34	89. 39. 25·4	55. 5·9	15. 2·3	50. 23. 48·75	54. 24. 23·0	40·0
I. 23. 10. 28·41	12. 12. 33·69	89. 41. 37·2	55. 5·7	15. 2·3	47. 56. 6·15	52. 12. 33·6	
II. 23. 11. 28·25	12. 12. 35·49	89. 41. 51·7	55. 5·7	15. 2·3	47. 56. 33·15	52. 13. 4·2	30·4
I. 23. 19. 10·76	12. 12. 49·34	89. 43. 43·4	55. 5·5	15. 2·2	45. 49. 4·20	50. 20. 8·8	
II. 23. 20. 10·59	12. 12. 51·14	89. 43. 57·9	55. 5·5	15. 2·2	45. 49. 31·20	50. 20. 39·6	28·6
I. 23. 28. 9·63	12. 13. 5·50	89. 45. 53·6	55. 5·3	15. 2·2	43. 38. 1·35	48. 25. 8·9	
II. 23. 29. 9·47	12. 13. 7·29	89. 46. 8·0	55. 5·3	15. 2·2	43. 38. 28·20	48. 25. 39·4	27·7
—	13. 18. 36·68	100. 30. 33·1	—	—	56. 24. 28·50	63. 51. 31·3	—
—	,,	,,	—	—	54. 10. 1·95	61. 57. 48·6	—
—	13. 18. 36·75	100. 30. 33·5	—	—	60. 59. 22·35	67. 47. 21·9	—
—	,,	,,	—	—	59. 1. 0·30	66. 5. 18·0	—
—	,,	,,	—	—	56. 57. 10·20	64. 19. 20·9	—
—	,,	,,	—	—	54. 58. 13·65	62. 38. 26·6	—
I. 23. 49. 24·59	13. 39. 38·03	100. 59. 56·0	54. 21·3	14. 50·1	57. 58. 15·90	66. 30. 40·4	
II. 23. 50. 24·43	13. 39. 39·83	101. 0. 9·1	54. 21·3	14. 50·1	57. 58. 42·90	66. 31. 10·0	39·9
I. 23. 57. 43·90	13. 39. 53·10	101. 1. 45·2	54. 21·2	14. 50·1	55. 56. 51·75	64. 47. 52·2	
II. 23. 58. 43·73	13. 39. 54·91	101. 1. 58·2	54. 21·2	14. 50·1	55. 57. 18·90	64. 48. 21·7	41·1
I. 0. 5. 9·17	13. 40. 6·58	101. 3. 22·9	54. 21·2	14. 50·1	54. 8. 36·60	63. 17. 0·3	
II. 0. 6. 9·01	13. 40. 8·39	101. 3. 35·9	54. 21·2	14. 50·1	54. 9. 3·75	63. 17. 29·8	39·5
I. 0. 12. 44·94	13. 40. 20·34	101. 5. 2·4	54. 21·1	14. 50·1	52. 17. 47·70	61. 44. 49·7	
II. 0. 13. 44·78	13. 40. 22·15	101. 5. 15·5	54. 21·1	14. 50·1	52. 18. 14·85	61. 45. 19·2	27·3
I. 0. 21. 17·31	13. 40. 35·82	101. 6. 54·3	54. 21·0	14. 50·1	50. 13. 13·35	60. 2. 19·3	
II. 0. 22. 17·14	13. 40. 37·63	101. 7. 7·3	54. 21·0	14. 50·1	50. 13. 40·50	60. 2. 48·7	25·1
I. 0. 29. 3·72	13. 40. 49·91	101. 8. 36·1	54. 21·0	14. 50·0	48. 19. 49·35	58. 30. 7·5	
II. 0. 30. 3·55	13. 40. 51·71	101. 8. 49·1	54. 21·0	14. 50·0	48. 20. 16·35	58. 30. 36·6	26·0
—	11. 7. 28·93	68. 47. 38·1	—	—	46. 54. 59·4	—	—
—	,,	,,	—	—	45. 1. 41·0	—	—
—	5. 48. 25·18	82. 37. 0·9	—		55. 44. 11·7	—	—
—	,,	,,	—	—	57. 31. 33·0	—	—

January 25. Aperture reduced.

January 27. Spica unsteady.

TABLE X.—LONGITUDE of HONOLULU from the OBSERVED RIGHT ASCENSION of the MOON on the MERIDIAN.

Day.		Observer.	Limb observed.	Observed R.A. of Moon's Limb on the Meridian.	Longitude by the Ephemeris. ϵ = the correction required to the Moon's Tabular R.A.	Adopted Value of ϵ.	Resulting Longitude, West.	Weight.	——
1874.				h m s	h m s	s	h m s		
Oct.	17	T	I.	19. 29. 1·29	10. 31. 14·86 − 24·36 ϵ	−0·34	10. 31. 23·1	6	Good observation, seven minutes after sunset. Clock correction depends upon three stars near the moon.
	18	T	I.	20. 27. 48·39	16·16 − 24·71 ϵ	·37	25·3	3	Cloudy. Moon observed on two wires only. Clock correction depends upon three stars near the moon.
	19	NO	I.	21. 25. 19·81	11·93 − 25·39 ϵ	·41	22·3	6	Good observation.
	20	R	I.	22. 21. 17·43	23·71 − 26·06 ϵ	·44	35·2	3	Cloudy. Clock correction unsatisfactory.
	21	T	I.	23. 16. 2·32	9·26 − 26·47 ϵ	·47	21·7	5	Good observation.
	23	T	I.	1. 5. 54·49	14·07 − 25·59 ϵ	·63	30·2	5½	Good observation.
	24	NO	II.	2. 3. 31·13	20·24 − 24·38 ϵ	·72	37·8	3	Moon observed at four wires, which are discordant; micrometer-reading doubtful. Bad night. Observer fatigued.
	27	NO	II.	5. 17. 52·31	30. 59·57 − 21·42 ϵ	·89	18·6	4	Tremor. Clock correction depends upon two stars near the moon, and is not satisfactory.
Nov.	15	NO	I.	21. 4. 26·52	31. 23·03 − 25·88 ϵ	·32	31·3	5½	Wires are discordant. Sun just set.
	16	T	I.	21. 59. 8·58	15·25 − 26·76 ϵ	·32	23·8	5	Good observation.
	22	T	I.	3. 32. 57·73	12·72 − 22·31 ϵ	·65	27·2	7	Good observation.
	,,	,,	II.	3. 35. 28·05	15·42 − 22·31 ϵ	·65	29·9	3½	Good observation. Correction for defective illumination, $+0^s·28$.
	23	T	II.	4. 41. 55·76	13·55 − 21·17 ϵ	·74	29·2	8	Good observation. Some tremor.
	27	T	II.	9. 1. 25·81	9·00 − 25·72 ϵ	·83	30·4	5½	Observer fatigued.
	28	R	II.	9. 54. 47·44	5·09 − 28·29 ϵ	·78	27·2	4½	Some tremor, but good observation.
	29	T	II.	10. 43. 38·00	4·29 − 30·64 ϵ	·71	26·0	4	Much tremor. Fair observation, 14 minutes before sunrise. Clock correction very satisfactory. Noisy gale.
Dec.	1	T	II.	12. 12. 55·70	9·99 − 33·30 ϵ	·60	30·0	4	One hour after sunrise. Limb bright and steady. The clock correction was determined 10 hours before the observation of the moon. Clock-rate very steady.
	2	T	II.	12. 55. 59·29	8·01 − 33·39 ϵ	·54	26·0	4	1¾ hours after sunrise. Limb fairly bright and steady. The clock correction was determined 12 hours after the observation of the moon. Clock-rate very steady.
	14	R	I.	22. 34. 51·87	14·75 − 27·83 ϵ	·35	24·5	5	The wires are discordant; 17 minutes before sunset.
	15	NO	I.	23. 26. 2·41	2·58 − 28·72 ϵ	·36	12·9	4½	Good observation.
	16	R	I.	0. 16. 54·67	19·15 − 28·16 ϵ	·39	30·1	4½	Good observation.
	17	NO	I.	1. 8. 50·97	10. 31. 16·04 − 27·19 ϵ	−0·43	10. 31. 27·7	5	Through clouds. Clock correction satisfactory.

Day.		Observer.	Limb observed.	Observed R.A. of Moon's Limb on the Meridian.	Longitude by the Ephemeris. ε = the correction required to the Moon's Tabular R.A.	Adopted Value of ε.	Resulting Longitude, West.	Weight.	——
1874.				h m s	h m s	s	h m s		
Dec.	18	R	I.	2. 3. 20·60	10. 31. 12·80 − 25·61 ε	−0·48	10. 31. 25·1	5½	Good observation.
	19	NO	I.	3. 1. 43·32	8·31 − 23·74 ε	·53	20·9	5	Raining. Much tremor. Clock correction satisfactory.
	20	NO	I.	4. 4. 41·35	16·57 − 22·09 ε	·60	29·8	7½	Good observation.
	21	T	I.	5. 11. 38·05	12·86 − 21·08 ε	·70	27·6	8	Three wires only, and through cloud.
	”	”	II.	5. 14. 12·62	12·88 − 21·08 ε	·70	27·8	4	Limb faint, through cloud; 18 hours before full moon. Correction for defective illumination, + 1s·40.
	22	NO	I.	6. 20. 18·40	8·41 − 21·05 ε	·79	25·0	8	Good observation. Correction for defective illumination, − 0s·12.
	”	”	II.	6. 22. 52·96	6·31 − 21·05 ε	·79	22·9	8	Good observation.
	24	R	II.	8. 32. 43·03	8·87 − 23·98 ε	·86	29·5	6	Good observation.
	29	T	II.	12. 38. 49·22	8·95 − 33·15 ε	·61	29·2	3½	Good observation.
	30	NO	II.	13. 22. 21·93	2·30 − 32·82 ε	·50	18·7	3½	Good observation, just after sunrise.
	31	T	II.	14. 6. 57·16	10·13 − 31·66 ε	·42	23·4	4	Good observation, 40 minutes after sunrise; limb bright and steady.
1875.									
Jan.	1	T	II.	14. 53. 39·08	9·88 − 29·94 ε	·35	20·4	4	Wires are discordant. Observation 1½ hours after sunrise.
	13	T	I.	0. 52. 4·11	12·90 − 28·04 ε	·42	24·7	3	Indifferent observation; four wires.
	14	R	I.	1. 44. 27·79	14·17 − 26·73 ε	·45	26·2	5	Two wires only. Limb steady.
	15	R	I.	2. 39. 47·11	16·12 − 25·18 ε	·49	28·5	6	Good observation.
	16	R	I.	3. 39. 3·99	16·41 − 23·44 ε	·53	28·8	6½	Good observation.
	17	R	I.	4. 42. 30·07	22·30 − 22·08 ε	·56	34·7	3½	One wire only. Clock correction satisfactory.
	18	R	I.	5. 48. 53·96	16·09 − 21·45 ε	·59	28·7	8	Good observation. Limb steady.
	19	T	I.	6. 55. 45·12	11·98 − 21·79 ε	·61	25·3	7½	Good observation. Some tremor.
	20	R	I.	8. 0. 9·56	9·00 − 23·08 ε	·62	23·3	7	Good observation. Some tremor.
	”	”	II.	8. 2. 36·87	9·02 − 23·08 ε	·62	23·3	3½	Good observation. Some tremor. Correction for defective illumination, + 0s·07.
	22	R	II.	9. 57. 18·37	12·14 − 27·59 ε	·60	28·7	4½	Good observation.
	23	NO	II.	10. 47. 39·38	4·76 − 29·73 ε	·57	21·7	4	Good observation.
	24	R	II.	11. 34. 38·47	14·49 − 31·50 ε	·54	31·5	3½	Good observation.
	25	T	II.	12. 19. 30·69	12·66 − 32·47 ε	·50	28·9	3½	Good observation.
	26	T	II.	13. 3. 32·12	16·36 − 32·73 ε	·46	31·4	3	Overcast; raining. Clock correction satisfactory.
	27	T	II.	13. 47. 54·34	13·45 − 32·03 ε	·42	26·9	3½	Good observation.
	28	T	II.	14. 33. 44·81	16·89 − 30·71 ε	·39	28·9	3½	Good observation.
	29	T	II.	15. 22. 2·27	13·30 − 28·92 ε	·38	24·3	4½	Good observation, 10 minutes after sunrise.
	30	T		16. 13. 31·01	15·97 − 27·06 ε	·37	26·0	5	Good observation, one hour after sunrise; limb bright and steady.
	31	R	II.	17. 8. 26·02	10. 31. 12·70 − 25·41 ε	−0·36	10. 31. 21·9	5½	Tremor; limb pretty bright; 1¾ hours after sunrise.

See page 23 for mean results.

TABLE XI.—ABSTRACT of LONGITUDES of HONOLULU from the observed ZENITH DISTANCES of the MOON'S FIRST LIMB, *i.e.*, U.L. when East, L.L. when West of the Meridian.

Day.		Observer.	No. of Observations.	Mean inferred Longitude from each Day's Observations.	Correction to Longitude for the Distance between the Instruments.	Seconds of Corrected Longitude.	Weight.	—
1874–5.				h m s	s	s		
October	15	T	4	10. 31. 25·2	+ 2·0	27·2	6	Z. D. about 81°.
	17	NI	3	9·4	1·6	11·4	0	Z. D. about 82°.
	18	T	6	26·7	1·5	28·2	5	Z. D. about 80°.
	19	NI	6	9·4	1·4	10·8	10	
	21	NI	8	18·4	1·4	19·8	13	
	22	NI	6	17·9	1·6	19·5	14	
	23	T	8	25·5	1·5	27·0	14	
	23	NI	4	21·6	1·6	23·2	14	
	24	NI	6	28·1	1·6	29·7	14	
November	14	NI	4	24·0	1·6	25·6	5	Z. D. about 84°.
	15	NI	6	22·7	1·6	24·3	10	
	16	NI	4	23·0	1·6	24·6	11	First four observations rejected.
	22	NI	6	17·7	1·7	19·4	13	
December	14	NI	6	19·3	1·5	21·8	11*	
	15	NI	6	24·5	1·6	26·1	12	
	18	NI	6	29·5	1·7	31·2	13	
	19	NI	6	24·7	1·7	26·4	13	
	20	NI	6	26·6	1·6	28·2	13	
	21	NI	6	27·5	1·6	29·1	13	
	22	T	6	18·1	1·6	19·7	0*	Defective limb.
January	11	T	6	29·0	1·6	30·6	12	
	13	NI	6	35·9	1·7	37·6	12	
	14	NI	6	34·2	1·7	35·9	12	
	15	T	6	23·1	1·8	24·9	12	
	16	NI	6	27·4	1·7	29·1	12	
	17	NI	6	23·1	1·7	24·8	10	
	18	NI	6	25·7	1·6	27·3	13	
	19	NI	6	23·9	1·7	25·6	12	
	19	T	8	18·6	1·7	20·3	12	
	20	T	6	19·6	1·7	21·3	12	
	20	NI	6	10. 31. 20·0	+ 1·7	21·7	12	

Mean, with weights, of corrected Longitudes by ☽ 1 L. .... h m s 10. 31. 25·5 (*see* page 27).

TABLE XI. (*continued*).—ABSTRACT of LONGITUDES of HONOLULU from the observed ZENITH DISTANCES of the MOON'S SECOND LIMB, *i.e.*, L.L. when East, U.L. when West of the Meridian.

Day.		Observer.	No. of Obser-vations.	Mean inferred Longitude from each Day's Observations.	Correction to Longitude for the Distance between the Instruments.	Seconds of Corrected Longitude.	Weight.	——
1874–5.				h m s	s	s		
October	3	T	6	10. 31. 19·0	+ 1·9	20·9	5*	
	4	NI	6	22·8	2·0	24·8	5*	
	5	NI	6	27·8	2·0	29·8	5*	
	7	T	6	28·7	——	——	0†	
	25	T	8	28·3	1·6	29·9	14	
	26	T	6	30·6	1·7	32·3	12	
	26	NI	6	24·1	1·6	25·7	13	
	27	T	4	18·2	1·6	19·8	12	
	27	NI	6	16·8	1·7	18·5	12	
	28	NI	6	20·9	1·6	22·5	6	
	29	NI	6	19·7	1·7	21·4	6	
November	4	T	3	19·1	——	——	0†	
	5	NI	2	21·4	——	——	0†	
	23	NI	8	30·2	1·5	31·7	12	
	26	NI	6	26·5	1·7	28·2	12	
	27	NI	12	32·1	1·7	33·8	12	
	28	NI	6	30·5	1·8	32·3	10	Limb indistinct.
	29	NI	6	26·8	2·0	28·8	10	
December	1	NI	6	28·1	2·0	30·1	9	
	2	NI	6	29·6	1·9	31·5	8	
	4	NI	4	31·4	1·9	33·3	8	
	22	T	6	23·8	1·6	25·4	6*	
	24	NI	6	29·3	1·7	31·0	6*	
	26	NI	6	32·5	1·9	34·4	5*	
	29	NI	6	29·9	2·0	31·9	9	
	30	NI	6	30·2	1·9	32·1	9	
	31	NI	6	26·2	1·8	28·0	8	
January	1	NI	6	269	1·8	28·7	8	
	20	NI	6	22·3	1·7	24·0	[illegible]	Defective limb.
	21	T	6	28·7	1·7	30·4	11	
	22	T	6	33·1	1·9	35·0	11	
	23	NI	6	34·3	1·9	36·2	5*	
	24	NI	6	38·7	1·9	40·6	5*	
	25	NI	6	35·1	1·9	37·0	5*	
	27	NI	6	10. 31. 33·1	1·8	34·9	5*	

Mean, with weights, of corrected Longitudes by ☽ 2 L. .... h m s 10. 31. 29·1 (*see* page 27).

* On these days the corrections to the Moon's Tabular Place are not satisfactory.
† Corrections wholly unknown.

CHRONOMETRIC CONNECTIONS.

TABLE XII.—COMPARISON of PORTABLE CHRONOMETERS with the TRANSIT-CLOCKS, and INFERRED ERROR of the PORTABLE CHRONOMETERS on Mean Time of Place.

Station and Approximate Local Mean Time (Civil Reckoning).	Time by the Transit-Clock.	Adopted Correction to the Transit-Clock.	Name of Portable-Chronometer compared.	Corresponding Time by Portable-Chronometer.	Inferred Portable-Chronometer Slow on Mean Time of Place.
	h m s	s		h m s	h m s
HONOLULU,	2. 33. 8·0	+ 9·36	W	7. 7. 0·0	+ 2. 26. 31·48
Dec. 5,	2. 40. 53·0	9·36	V	7. 1. 36·5	2. 39. 38·71
9h. 41m. p.m.	2. 43. 32·0	+ 9·36	M	9. 40. 31·0	+ 0. 3. 22·77
KAILUA,	19. 37. 10·0	+ 30·29	Q	2. 24. 40·5	+ 0. 6. 31·36
Dec. 7,	19. 44. 55·0	30·30	Q	2. 32. 24·0	0. 6. 31·60
2h. 40m. p.m.	19. 42. 20·0	30·30	V	11. 48. 55·5	2. 47. 25·52
	19. 57. 17·0	30·31	V	0. 3. 50·0	2. 47. 25·59
	19. 48. 24·0	30·30	W	0. 8. 11·5	2. 34. 12·53
	19. 51. 55·0	+ 30·31	W	0. 11. 42·0	+ 2. 34. 12·45
KAILUA,	16. 45. 50·0	+ 33·44	Q	11. 26. 0·5	+ 0. 6. 30·73
Dec. 9,	16. 48. 55·0	33·44	Q	11. 29. 5·0	0. 6. 30·73
Noon.	16. 52. 38·0	33·45	V	8. 51. 28·0	2. 47. 50·12
	16. 58. 39·0	33·45	V	8. 57. 28·0	2. 47. 50·14
	16. 50. 15·0	33·44	W	9. 2. 25·5	2. 34. 30·01
	16. 56. 14·0	+ 33·45	W	9. 8. 23·5	+ 2. 34. 30·04
HONOLULU,	18. 20. 0·0	+ 11·07	R	1. 1. 58·0	+ 0. 0. 8·40
Dec. 10,	18. 21. 15·0	11·07	V	10. 22. 42·0	2. 40. 39·19
1h. 3m. p.m.	18. 28. 10·0	+ 11·07	W	10. 43. 0·0	+ 2. 27. 15·06
HONOLULU,	15. 51. 36·0	+ 12·08	U	19. 0. 43·5	+ 3. 17. 40·53
Dec. 14,	16. 2. 33·0	12·08	V	19. 47. 51·5	2. 41. 27·74
10h. 30m. a.m.	16. 2. 25·0	12·08	V	19. 47. 43·5	2. 41. 27·76
	15. 55. 52·0	12·08	W	19. 54. 48·5	2. 27. 50·84
	15. 55. 42·0	+ 12·08	W	19. 54. 38·5	+ 2. 27. 50·87
KAILUA,	20. 25. 20·0	+ 46·44	U	11. 22. 48·5	+ 3. 25. 14·27
Dec. 15,	20. 20. 26·0	46·43	V	11. 54. 2·0	2. 49. 7·57
2h. 45m. p.m.	20. 17. 45·0	+ 46·43	W	0. 5. 2·5	+ 2. 35. 26·51
KAILUA,	18. 9. 40·0	+ 50·25	U	8. 59. 26·5	+ 3. 25. 30·45
Dec. 17,	18. 12. 7·0	50·26	V	9. 37. 52·0	2. 49. 31·57
0h. 27m. p.m.	18. 5. 4·0	+ 50·25	W	9. 44. 38·0	+ 2. 35. 43·71

Station and Approximate Local Mean Time (Civil Reckoning).	Time by the Transit-Clock.	Adopted Correction to the Transit-Clock.	Name of Portable-Chronometer compared.	Corresponding Time by Portable-Chronometer.	Inferred Portable-Chronometer Slow on Mean Time of Place.
	h m s	s		h m s	h m s
HONOLULU,	18. 0. 5·0	+ 13·39	U	8. 52. 35·5	+ 3. 18. 14·14
Dec. 18,	18. 3. 8·0	13·39	U	8. 55. 38·0	3. 18. 14·14
0h. 20m. p.m.	18. 7. 5·0	13·39	V	9. 35. 29·0	2. 42. 19·49
	18. 10. 10·0	13·39	V	9. 38. 33·5	2. 42. 19·48
	18. 13. 25·0	13·39	W	9. 55. 39·5	2. 28. 27·95
	18. 16. 25·0	+ 13·39	W	9. 58. 39·0	+ 2. 28. 27·96
HONOLULU,	18. 8. 40·0	+ 13·79	U	8. 57. 4·0	+ 3. 18. 23·72
Dec. 19,	18. 11. 41·0	13·79	U	9. 0. 4·5	3. 18. 23·72
0h. 20m. p.m.	18. 18. 5·0	13·80	V	9. 42. 19·0	2. 42. 32·19
	18. 21. 5·0	13·80	V	9. 45. 18·5	2. 42. 32·20
	18. 27. 31·0	13·80	W	10. 5. 38·5	2. 28. 37·14
	18. 30. 30·0	+ 13·80	W	10. 8. 37·0	+ 2. 28. 37·15
		m s			
WAIMEA,*	22. 25. 9·0	− 7. 6·97	A A	4. 27. 20·0	− 0. 7. 21·94
Dec. 20,	22. 31. 54·0	7. 6·96	U	1. 15. 23·0	+ 3. 11. 18·96
4h. 30m. p.m.	22. 37. 35·0	7. 6·95	V	1. 56. 50·0	2. 35. 32·04
	22. 43. 38·0	− 7. 6·95	W	2. 16. 50·0	+ 2. 21. 34·05
HONOLULU,	20. 25. 10·0	+ 0. 14·99	U	11. 5. 4·5	+ 3. 18. 40·24
Dec. 21,	20. 26. 43·0	0. 14·99	V	11. 42. 21·0	2. 42. 56·49
2h. 25m. p.m.	20. 30. 31·0	+ 0. 14·99	W	0. 0. 9·0	+ 2. 28. 55·87
HONOLULU,	18. 23. 2·0	+ 0. 15·50	U	8. 59. 13·0	+ 3. 18. 48·33
Dec. 22,	18. 26. 0·0	0. 15·50	U	9. 2. 10·5	3. 18. 48·35
0h. 25m. p.m.	18. 28. 23·0	0. 15·50	V	9. 40. 14·5	2. 43. 6·97
	18. 31. 24·0	0. 15·51	V	9. 43. 15·0	2. 43. 6·97
	18. 35. 9·0	0. 15·51	W	10. 1. 2·5	2. 29. 3·86
	18. 38. 7·0	+ 0. 15·51	W	10. 4. 0·0	+ 2. 29. 3·88
WAIMEA,*	21. 3. 50·0	− 7. 2·50	U	11. 35. 25·5	+ 3. 11. 43·60
Dec. 23,	21. 6. 50·0	7. 2·49	U	11. 38. 25·0	3. 11. 43·62
2h. 55m. p.m.	21. 12. 15·0	7. 2·49	V	12. 19. 26·0	2. 36. 6·73
	21. 20. 26·0	− 7. 2·48	W	12. 41. 42·0	+ 2. 22. 0·40
HONOLULU,	21. 0. 17·0	+ 0. 17·11	U	11. 27. 55·0	+ 3. 19. 5·36
Dec. 24,	21. 6. 21·0	0. 17·11	V	0. 9. 31·5	2. 43. 31·87
2h. 53m. p.m.	21. 11. 15·0	+ 0. 17·11	W	0. 28. 34·0	+ 2. 29. 22·57

* The adopted errors of the Sidereal Chronometer at Waimea are such as make that chronometer represent the mean of the three in regard to carrying on time.

Station and Approximate Local Mean Time (Civil Reckoning).	Time by the Transit-Clock.	Adopted Correction to the Transit-Clock.	Name of Portable-Chronometer compared.	Corresponding Time by Portable-Chronometer.	Inferred Portable-Chronometer Slow on Mean Time of Place.
	h m s	m s		h m s	h m s
HONOLULU,	21. 31. 37·0	+ 0. 20·36	U	11. 34. 46·5	+ 3. 19. 56·49
Dec. 30,	21. 35. 45·0	0. 20·36	V	0. 14. 7·0	2. 44. 43·32
3h. 0m. p.m.	21. 39. 49·0	+ 0. 20·36	W	0. 32. 37·5	+ 2. 30. 16·15
HONOLULU,	18. 37. 51·0	+ 0. 21·53	U	8. 29. 18·0	+ 3. 20. 20·88
1875, Jan. 2,	18. 40. 51·0	0. 21·53	V	9. 7. 21·0	2. 45. 17·38
11h. 54m. a.m.	18. 43. 51·0	0. 21·54	V	9. 10. 20·5	2. 45. 17·40
	18. 46. 27·0	+ 0. 21·54	W	9. 27. 31·0	+ 2. 30. 42·48
KAILUA,	19. 59. 5·0	+ 0. 20·68	U	9. 38. 50·0	+ 3. 27. 54·03
Jan. 3,	20. 3. 27·0	0. 20·68	V	10. 18. 11·5	(2. 52. 53·81)
1h. 14m. p.m.	20. 6. 28·0	0. 20·68	V	10. 21. 11·0	2. 52. 54·82
	20. 9. 43·0	+ 0. 20·68	W	10. 39. 3·5	+ 2. 38. 16·79
KAILUA,	1. 56. 25·0	+ 0. 23·00	U	3. 31. 7·5	+ 3. 28. 4·39
Jan. 4,	2. 0. 19·0	0. 23·01	V	4. 9. 55·5	2. 53. 9·76
7h. 5m. p.m.	2. 3. 26·0	0. 23·01	V	4. 13. 2·0	2. 53. 9·75
	2. 7. 42·0	+ 0. 23·02	W	4. 31. 58·5	+ 2. 38. 28·56
HONOLULU,	19. 30. 55·0	+ 0. 24·58	U	9. 5. 59·5	+ 3. 20. 54·07
Jan. 6,	19. 34. 12·0	0. 24·58	V	9. 44. 5·5	2. 46. 4·53
0h. 30m. p.m.	19. 38. 37·0	0. 24·58	W	10. 3. 15·0	2. 31. 19·31
	19. 41. 31·0	+ 0. 24·58	W	10. 6. 8·5	+ 2. 31. 19·33
HONOLULU,	22. 25. 2·0	+ 0. 27·61	U	11. 47. 25·5	+ 3. 21. 21·84
Jan. 9,	22. 31. 43·0	0. 27·61	V	0. 28. 50·5	2. 46. 36·75
3h. 15m. p.m.	22. 37. 0·0	+ 0. 27·62	W	0. 48. 56·0	+ 2. 31. 47·39
WAIMEA,*	21. 4. 6·0	− 6. 26·53	U	10. 22. 58·0	+ 3. 14. 16·70
Jan. 10,	21. 8. 50·0	6. 26·52	V	11. 2. 23·5	2. 39. 34·23
1h. 42m. p.m.	21. 12. 50·0	− 6. 26·52	W	11. 21. 14·5	+ 2. 24. 42·57
WAIMEA,*	23. 19. 13·0	− 6. 25·00	U	0. 33. 40·0	+ 3. 14. 24·97
Jan. 11,	23. 24. 30·0	6. 25·00	V	1. 13. 35·0	2. 39. 46·10
3h. 53m. p.m.	23. 28. 32·0	− 6. 24·99	W	1. 32. 30·5	+ 2. 24. 51·95

* *See* note to preceding page.

Station and Approximate Local Mean Time (Civil Reckoning).	Time by the Transit-Clock.	Adopted Correction to the Transit-Clock.	Name of Portable-Chronometer compared.	Corresponding Time by Portable-Chronometer.	Inferred Portable-Chronometer Slow on Mean Time of Place.
	h m s	m s		h m s	h m s
HONOLULU,	22. 22. 23·0	+ 0. 30·16	U	11. 32. 37·0	+ 3. 21. 46·58
Jan. 12,	22. 28. 48·0	0. 30·16	V	0. 13. 37·0	2. 47. 10·53
$3^h. 0^m.$ p.m.	22. 31. 20·0	+ 0. 30·16	W	0. 31. 5·0	+ 2. 32. 14·11
HONOLULU,	20. 8. 11·0	+ 0. 30·93	U	9. 14. 44·0	+ 3. 21. 54·42
Jan. 13,	20. 11. 17·0	0. 30·94	V	9. 52. 23·5	2. 47. 20·42
$0^h. 40^m.$ p.m.	20. 16. 46·0	+ 0. 30·94	W	10. 12. 50·0	+ 2. 32. 22·02

TABLE XIII.—SPECIMEN of the COMPARISON of the PORTABLE-CHRONOMETERS with the SHIP-CHRONOMETERS and ADOPTED ERRORS at each STATION.

1. HONOLULU, 1874, December 5, at $9^h. 40^m.$ p.m.

Name of Ship-Chronometer.	Ship-Chronometer Time.	Ship-Chronometer Fast on each Portable-Chronometer at the Time specified in the Second Column.*			Adopted Ship-Chronometer Slow on Honolulu Mean Time.	Name of Chronometer.
		Fast on M.	Fast on V.	Fast on W.		
	h m	h m s	h m s	h m s	h m s	
E	9. 45	0. 8. 25·51	2. 44. 41·45	2. 31. 34·19	− 0. 5. 2·73	E
F	9. 39	0. 3. 18·06	2. 39. 34·00	2. 26. 27·08	+ 0. 0. 4·61	F
K	9. 36	11. 59. 39·21	2. 35. 55·15	2. 22. 47·99	0. 3. 43·54	K
U	6. 23	8. 47. 3·79	11. 23. 19·67	11. 10. 12·53	+ 3. 16. 18·99	U

2. KAILUA, 1874, December 7, at about $2^h. 30^m.$ p.m.

Name of Ship-Chronometer.	Ship-Chronometer Time.	Ship-Chronometer Fast of each Portable-Chronometer at the Time specified in the Second Column.*			Adopted Ship-Chronometer Slow on Kailua Mean Time.	Name of Chronometer.
		Fast on Q.	Fast on V.	Fast on W.		
	h m	h m s	h m s	h m s	h m s	
E	2. 38	0. 4. 9·89	2. 45. 4·10	2. 31. 51·16	+ 0. 2. 21·46	E
F	2. 32	11. 58. 52·32	2. 39. 46·67	2. 26. 34·02	0. 7. 34·84	F
K	2. 29	11. 55. 7·27	2. 36. 1·64	2. 22. 48·48	0. 11. 24·04	K
U	11. 17	8. 42. 31·02	11. 23. 25·08	11. 10. 12·00	3. 24. 0·47	U
M	2. 29	11. 55. 31·40	2. 36. 25·74	2. 23. 12·98	+ 0. 10. 59·80	M

* In this Table each inferred difference between a Ship- and a Portable-Chronometer has been interpolated from the comparisons made before and after landing the Portable-Chronometers.

TABLE XIV.—ABSTRACT of ERRORS of TRAVELLING CHRONOMETERS on LOCAL MEAN TIME.

Name of Chronometer.	Honolulu, December 5, 9h. 40m. p.m.		Kailua, December 7, 2h. 40m. p.m.		Kailua, December 9, Noon.	
	Chronometer Time.	Chronometer Slow on Honolulu Mean Time.	Chronometer Time.	Chronometer Slow on Kailua Mean Time.	Chronometer Time.	Chronometer Slow on Kailua Mean Time.
	h m	h m s	h m	h m s	h m	h m s
A						
B						
C						
D						
E	9. 45	− 0. 5. 2·73	2. 38	+ 0. 2. 21·46	11. 36	+ 0. 2. 20·46
F	9. 39	+ 0. 0. 4·61	2. 32	+ 0. 7. 38·84	11. 31	+ 0. 7. 48·84
G						
H (Sid.)						
K	9. 36	+ 0. 3. 43·54	2. 29	+ 0. 11. 24·04	11. 27	+ 0. 11. 41·30
M	9. 40	+ 0. 3. 22·77	2. 29	+ 0. 10. 59·80	11. 27	+ 0. 11. 13·70
R B						
R M						
A A						
B B						
C C						
D D						
E E						
F F						
G G						
U	6. 23	+ 3. 16. 18·99	11. 17	+ 3. 24. 0·47	8. 14	+ 3. 24. 19·12
V	7. 2	+ 2. 39. 38·71	11. 56	+ 2. 47. 25·55	8. 54	+ 2. 47. 50·13
W	7. 7	+ 2. 26. 31·48	12. 10	+ 2. 34. 12·49	9. 5	+ 2. 34. 30·02

Name of Chronometer.	Honolulu, December 10, 1h. p.m.		Honolulu, December 14, 10h. 20m. a.m.		Kailua, December 15, between 0h. 30m. and 2h. 50m. p.m.	
	Chronometer Time.	Chronometer Slow on Honolulu Mean Time.	Chronometer Time.	Chronometer Slow on Honolulu Mean Time.	Chronometer Time.	Chronometer Slow on Kailua Mean Time.
	h m	h m s	h m	h m s	h m	h m s
A			10. 27	− 0. 3. 31·75	0. 25	+ 0. 3. 53·12
B			10. 31	− 0. 7. 55·17	2. 9	− 0. 0. 33·37
C			10. 31	− 0. 8. 17·55	2. 11	− 0. 0. 56·97
D			10. 19	+ 0. 4. 20·10	0. 24	+ 0. 11. 52·36
E	1. 10	− 0. 5. 4·32	10. 28	− 0. 5. 7·10	2. 10	+ 0. 2. 17·29
F	1. 6	+ 0. 0. 31·37	10. 22	+ 0. 0. 50·48	0. 33	+ 0. 8. 21·17
G			10. 23	− 0. 0. 21·40	0. 36	+ 0. 7. 7·49
H (Sid.)*			15. 57	(+ 0. 2. 18·15)	18. 14	(+ 0. 9. 44·25)
K	1. 1	+ 0. 4. 27·95	10. 18	+ 0. 5. 3·56	0. 36	+ 0. 12. 38·31
M	1. 1	+ 0. 3. 58·55	10. 19	+ 0. 4. 24·98	0. 38	+ 0. 11. 58·08
R B			8. 52	+ 1. 30. 48·68	11. 17	+ 1. 38. 11·79

* In this Table the Errors and Rates of Chronometer H are on Local Sidereal Time.

Name of Chronometer.	HONOLULU, December 10, 1h. p.m.		HONOLULU, December 14, 10h. 20m. a.m.		KAILUA, December 15, between 0h. 30m. and 2h. 50m. p.m.	
	Chronometer Time.	Chronometer Slow on Honolulu Mean Time.	Chronometer Time.	Chronometer Slow on Honolulu Mean Time.	Chronometer Time.	Chronometer Slow on Kailua Mean Time.
	h m	h m s	h m	h m s	h m	h m s
R M			1. 10	− 2. 47. 3·08	3. 32	− 2. 39. 56·50
A A			10. 23	+ 0. 0. 1·33	0. 57	+ 0. 7. 24·06
B B			8. 34	+ 1. 48. 38·41	11. 10	+ 1. 56. 7·82
C C			10. 23	+ 0. 0. 3·83	1. 1	+ 0. 7. 29·29
D D			10. 23	− 0. 0. 28·49	1. 3	+ 0. 6. 56·88
E E			10. 23	+ 0. 0. 5·77	1. 4	+ 0. 7. 31·98
F F			10. 23	+ 0. 0. 24·96	1. 5	+ 0. 7. 49·99
G G			10. 23	+ 0. 0. 12·51	1. 7	+ 0. 7. 46·46
U	9. 48	+ 3. 17. 4·26	7. 1	+ 3. 17. 40·53	11. 23	+ 3. 25. 14·27
V	10. 23	+ 2. 40. 39·19	7. 48	+ 2. 41. 27·75	11. 54	+ 2. 49. 7·57
W	10. 43	+ 2. 27. 15·06	7. 55	+ 2. 27. 50·85	0. 5	+ 2. 35. 26·51

Name of Chronometer.	KAILUA, December 17, near noon.		HONOLULU, December 18, about 11h. a.m.		HONOLULU, December 19, about 2h. p.m.	
	Chronometer Time.	Chronometer Slow on Kailua Mean Time.	Chronometer Time.	Chronometer Slow on Honolulu Mean Time.	Chronometer Time.	Chronometer Slow on Honolulu Mean Time.
	h m	h m s	h m	h m s	h m	h m s
A	11. 54	+ 0. 3. 54·17	16. 36	− 0. 3. 29·63	1. 57	− 0. 3. 28·76
B	0. 0	− 0. 0. 38·96	10. 44	− 0. 8. 6·14	2. 5	− 0. 8. 9·13
C	0. 4	− 0. 1. 4·14	10. 46	− 0. 8. 32·51	2. 6	− 0 8. 36·38
D	11. 53	+ 0. 12. 6·75	10. 36	+ 0. 4. 48·86	1. 56	+ 0. 4. 58·24
E	0. 5	+ 0. 2. 16·32	10. 48	− 0. 5. 9·08	2. 7	− 0. 5. 9·59
F	0. 7	+ 0. 3. 31·51	10. 44	+ 0. 1. 12·43	2. 1	+ 0. 1. 18·63
G	0. 4	+ 0. 7. 14·84	10. 47	− 0. 0. 5·70	2. 5	− 0. 0. 0·98
H (Sid.)	17. 51	(+ 0. 9. 46·54)	16. 36	(+ 0. 2. 22·61)	19. 57	(+ 0. 2 24·46)
K	0. 4	+ 0. 12. 56·55	10. 46	+ 0. 5. 41·13	2. 2	+ 0. 5. 51·53
M	0. 7	+ 0. 12. 13·03	10. 49	+ 0. 4. 56·30	2. 5	+ 0. 5. 5·17
R B	10. 46	+ 1. 38. 9·47	9. 27	+ 1. 30. 42·66	0. 43	+ 1. 30. 41·97
R M	3. 2	− 2. 40. 28·90	1. 44	− 2. 48. 9·00	5. 1	− 2. 48. 27·18
A A	0. 30	+ 0. 7. 21·03	11. 14	− 0. 0. 5·31	2. 30	− 0. 0. 6·52
B B	10. 43	+ 1. 55. 15·42	9. 27	+ 1. 48. 54·09	0. 43	+ 1. 48. 59·05
C C	0. 32	+ 0. 7. 32·30	11. 18	+ 0. 0. 9·30	2. 33	+ 0. 0. 12·04
D D	0. 36	+ 0. 6. 57·45	11. 21	− 0. 0. 26·71	2. 36	− 0. 0. 25·61
E E	0. 37	+ 0. 7. 34·17	11. 23	+ 0. 0. 10·54	2. 37	+ 0. 0. 12·32
F F	0. 38	+ 0. 7. 51·95	11. 24	+ 0. 0. 28·15	2. 39	+ 0. 0. 29·43
G G	0. 41	+ 0. 8. 1·71	11. 27	+ 0. 0. 44·61	2. 40	+ 0. 0. 53·73
U	8. 59	+ 3. 25. 30·45	8. 54	+ 3. 18. 14·14	8. 58	+ 3. 18. 23·72
V	9. 38	+ 2. 49. 31·57	9. 36	+ 2. 42. 19·49	9. 42	+ 2. 42. 32·19
W	9. 45	+ 2. 35. 43·71	9. 56	+ 2. 28. 27·95	10. 6	+ 2. 28. 37·14

Name of Chronometer.	WAIMEA, December 20, about 4h. p.m.		HONOLULU, December 21, about 1h. p.m.		HONOLULU, December 22, about 2h. p.m.	
	Chronometer Time.	Chronometer Slow on Waimea Mean Time.	Chronometer Time.	Chronometer Slow on Honolulu Mean Time.	Chronometer Time.	Chronometer Slow on Honolulu Mean Time.
	h m	h m s	h m	h m s	h m	h m s
A	2. 5	− 0. 10. 42·61	1. 0	− 0. 3. 29·60	1. 28	− 0. 3. 30·85
B	4. 7	− 0. 15. 26·52	1. 7	− 0. 8. 15·66	1. 36	− 0. 8. 18·86
C	4. 10	− 0. 15. 54·06	1. 9	− 0. 8. 43·53	1. 39	− 0. 8. 47·23
D	4. 0	− 0. 2. 7·94	0. 58	+ 0. 5. 11·71	1. 27	+ 0. 5. 18·76
E	4. 13	− 0. 12. 24·49	1. 10	− 0. 5. 11·20	1. 40	− 0. 5. 12·35
F	4. 9	− 0. 5. 48·98	1. 5	+ 0. 1. 29·04	1. 35	+ 0. 1. 33·57
G	4. 12	− 0. 7. 10·88	1. 8	+ 0. 0. 5·68	1. 39	+ 0. 0. 8·67
H (Sid.)	22. 11	(− 0. 4. 47·69)	19. 11	(+ 0. 2. 27·43)	19. 44	(+ 0. 2. 30·90)
K	4. 12	− 0. 1. 12·07	1. 8	+ 0. 6. 9·01	1. 38	+ 0. 6. 16·55
M	4. 15	− 0. 2. 0·29	1. 10	+ 0. 5. 19·70	1. 41	+ 0. 5. 25·82
R B	2. 55	+ 1. 23. 26·59	11. 48	+ 1. 30. 38·91	0. 20	+ 1. 30. 37·76
R M	7. 12	− 2. 55. 58·90	4. 6	− 2. 49. 0·08	4. 38	− 2. 49. 17·40
A A	4. 27	− 0. 7. 21·94	1. 32	− 0. 0. 9·57	2. 7	− 0. 0. 11·44
B B	2. 52	+ 1. 41. 49·08	11. 44	+ 1. 49. 5·80	0. 20	+ 1. 49. 9·48
C C	4. 43	− 0. 7. 0·11	1. 35	+ 0. 0. 14·16	2. 11	+ 0. 0. 14·93
D D	4. 46	− 0. 7. 39·15	1. 37	− 0. 0. 25·40	2. 14	− 0. 0. 25·23
E E	4. 48	− 0. 7. 0·48	1. 39	+ 0. 0. 13·95	2. 17	+ 0. 0. 14·51
F F	4. 50	− 0. 6. 42·72	1. 40	+ 0. 0. 32·09	2. 19	+ 0. 0. 33·25
G G	4. 53	− 0. 6. 12·30	1. 41	+ 0. 1. 7·52	2. 21	+ 0. 1. 14·86
U	1. 15	+ 3. 11. 18·96	11. 5	+ 3. 18. 40·24	9. 0	+ 3. 18. 48·34
V	1. 57	+ 2. 35. 32·04	11. 42	+ 2. 42. 56·49	9. 41	+ 2. 43. 6·97
W	2. 17	+ 2. 21. 34·05	0. 0	+ 2. 28. 55·87	10. 2	+ 2. 29. 3·87

Name of Chronometer.	WAIMEA, December 23, about 3h. p.m.		HONOLULU, December 24, about 3h. p.m.		HONOLULU, December 30, about 3h. p.m.	
	Chronometer Time.	Chronometer Slow on Waimea Mean Time.	Chronometer Time.	Chronometer Slow on Honolulu Mean Time.	Chronometer Time.	Chronometer Slow on Honolulu Mean Time.
	h m	h m s	h m	h m s	h m	h m s
A	2. 53	− 0. 10. 45·85	2. 24	− 0. 3. 23·86	2. 33	− 0. 3. 40·70
B	3. 0	− 0. 15. 36·01	2. 31	− 0. 8. 26·08	2. 41	− 0. 8. 46·80
C	3. 4	− 0. 16. 4·03	2. 34	− 0. 8. 53·88	2. 45	− 0. 9. 16·01
D	2. 52	− 0. 1. 47·23	2. 22	+ 0. 5. 32·85	2. 31	+ 0. 6. 11·62
E	3. 5	− 0. 12 26·67	2. 35	− 0. 5. 14·40	2. 45	− 0. 5. 22·30
F	3. 1	− 0. 5. 34·66	2. 30	+ 0. 1. 43·19	2. 38	+ 0. 2. 6·95
G	3. 5	− 0. 7. 1·48	2. 33	+ 0. 0. 14·86	2. 42	+ 0. 0. 27·96
H (Sid.)	21. 15	(− 0. 4. 40·56)	20. 47	(+ 0. 2. 34·23)	21. 19	(+ 0. 2. 43·51)
K	3. 4	− 0. 0. 47·74	2. 31	+ 0. 6. 33·60	2. 39	+ 0. 7. 16·62
M	3. 7	− 0. 1. 40·38	2. 34	+ 0. 5. 39·61	2. 42	+ 0. 6. 12·71
R B	1. 48	+ 1. 23. 22·97	1. 13	+ 1. 30. 34·80	1. 21	+ 1. 30. 27·17

Name of Chronometer.	WAIMEA, December 23, about 3h. p.m.		HONOLULU, December 24, about 3h. p.m.		HONOLULU, December 30, about 3h. p.m.	
	Chronometer Time.	Chronometer Slow on Waimea Mean Time.	Chronometer Time.	Chronometer Slow on Honolulu Mean Time.	Chronometer Time.	Chronometer Slow on Honolulu Mean Time.
	h m	h m s	h m	h m s	h m	h m s
R M	6. 5	− 2. 56. 48·86	5. 32	− 2. 49. 52·41	5. 41	− 2. 51. 37·94
A A	3. 24	− 0. 7. 26·44	2. 49	− 0. 0. 14·47	2. 58	− 0. 0. 25·78
B B	1. 36	+ 1. 41. 59·41	1. 2	+ 1. 49. 15·81	1. 10	+ 1. 49. 33·48
C C	3. 28	− 0. 6. 57·63	2. 52	+ 0. 0. 16·14	3. 3	+ 0. 0. 20·15
D D	3. 32	− 0. 7. 38·63	2. 54	− 0. 0. 25·22	3. 6	− 0. 0. 27·28
E E	3. 34	− 0. 6. 57·98	2. 55	+ 0. 0. 16·37	3. 7	+ 0. 0. 18·65
F F	3. 36	− 0. 6. 38·95	2. 59	+ 0. 0. 35·72	3. 9	+ 0. 0. 41·90
G G	3. 38	− 0. 5. 51·15	2. 59	+ 0. 1. 28·41	3. 9	+ 0. 2. 3·07
U	11. 37	+ 3. 11. 43·61	11. 28	+ 3. 19. 5·36	11. 35	+ 3. 19. 56·49
V	0. 19	+ 2. 36. 6·73	0. 10	+ 2. 43. 31·87	0. 14	+ 2. 44. 43·32
W	0. 39	+ 2. 22. 0·40	0. 29	+ 2. 29. 22·57	0. 33	+ 2. 30. 16·65

Name of Chronometer.	HONOLULU, 1875, January 2, Noon.		KAILUA, January 3, about 1h. p.m.		KAILUA, January 4, about 7h. p.m.	
	Chronometer Time.	Chronometer Slow on Honolulu Mean Time.	Chronometer Time.	Chronometer Slow on Kailua Mean Time.	Chronometer Time.	Chronometer Slow on Kailua Mean Time.
	h m	h m s	h m	h m s	h m	h m s
A	11. 53	− 0. 3. 42·16	0. 29	+ 0. 3. 42·09	6. 38	+ 0. 3. 42·26
B	0. 1	− 0. 8. 56·76	0. 38	− 0. 1. 35·64	6. 46	− 0. 1. 39·80
C	0. 4	− 0. 9. 26·54	0. 42	− 0. 2. 5·55	6. 49	− 0. 2. 10·01
D	11. 49	+ 0. 6. 32·24	0. 27	+ 0. 14. 4·10	6. 34	+ 0. 14. 14·11
E	0. 3	− 0. 5. 26·29	0. 40	+ 0. 1. 57·02	6. 48	+ 0. 1. 55·89
F	11. 57	+ 0. 2. 18·73	0. 34	+ 0. 9. 48·36	6. 42	+ 0. 9. 54·61
G	0. 0	+ 0. 0. 35·01	0. 38	+ 0. 8. 2·53	6. 46	+ 0. 8. 6·49
H (Sid.)	18. 48	(+ 0. 2. 48·27)	19. 31	(+ 0. 10. 14·01)	1. 43	(+ 0. 10. 15·67)
K	11. 56	+ 0. 7. 39·27	0. 36	+ 0. 15. 12·48	6. 43	+ 0. 15. 23·39
M	11. 59	+ 0. 6. 30·32	0. 40	+ 0. 14. 2·45	6. 46	+ 0. 14. 11·37
R B	10. 38	+ 1. 30. 22·29	11. 20	+ 1. 37. 44·30	5. 26	+ 1. 37. 41·98
R M	3. 0	− 2. 52. 28·58	3. 41	− 2. 45. 22·03	9. 48	− 2. 45. 43·74
A A	0. 13	− 0. 0. 30·83	0. 55	+ 0. 6. 53·35	6. 59	+ 0. 6. 52·11
B B	10. 24	+ 1. 49. 41·95	11. 7	+ 1. 57. 9·61	5. 12	+ 1. 57. 13·62
C C	0. 15	+ 0. 0. 24·37	0. 59	+ 0. 7. 50·58	7. 3	+ 0. 7. 53·34
D D	0. 17	− 0. 0. 28·93	1. 2	+ 0. 6. 55·57	7. 6	+ 0. 6. 55·86
E E	0. 18	+ 0. 0. 20·35	1. 3	+ 0. 7. 45·97	7. 7	+ 0. 7. 47·27
F F	0. 20	+ 0. 0. 45·46	1. 4	+ 0. 8. 11·61	7. 10	+ 0. 8. 13·77
G G	0. 20	+ 0. 2. 22·03	1. 5	+ 0. 9. 54·00	7. 10	+ 0. 10. 3·45
U	8. 29	+ 3. 20. 20·88	9. 39	+ 3. 27. 54·03	3. 31	+ 3. 28. 4·39
V	9. 7	+ 2. 45. 17·38	10. 21	+ 2. 52. 54·82	4. 10	+ 2. 53. 9·76
W	9. 28	+ 2. 30. 42·48	10. 39	+ 2. 38. 16·79	4. 32	+ 2. 38. 28·56

Name of Chronometer.	HONOLULU, January 6, about 1h. p.m.		HONOLULU, January 9, about 3h. p.m.		WAIMEA, January 10, about 1h. p.m.	
	Chronometer Time.	Chronometer Slow on Honolulu Mean Time.	Chronometer Time.	Chronometer Slow on Honolulu Mean Time.	Chronometer Time.	Chronometer Slow on Waimea Mean Time.
	h m	h m s	h m	h m s	h m	h m s
A	0. 32	− 0. 3. 44·09	2. 37	− 0. 3. 49·02	1. 15	− 0. 11. 3·58
B	0. 39	− 0. 9. 10·35	2. 44	− 0. 9. 21·96	1. 24	− 0. 16. 38·78
C	0. 42	− 0. 9. 40·69	2. 46	− 0. 9. 50·80	1. 26	− 0. 17. 6·87
D	0. 26	+ 0. 7. 2·13	2. 30	+ 0. 7. 24·29	1. 10	+ 0. 0. 17·96
E	0. 40	− 0. 5. 31·13	2. 44	− 0. 5. 35·54	1. 25	− 0. 12. 50·03
F	0. 34	+ 0. 2. 37·16	2. 37	+ 0. 2. 49·12	1. 20	− 0. 4. 19·83
G	0. 37	+ 0. 0. 46·66	2. 40	+ 0. 0. 51·51	1. 23	− 0. 6. 19·73
H (Sid.)	19. 41	(+ 0. 2. 52·11)	21. 56	(+ 0. 2. 53·65)	20. 43	(− 0. 4. 19·04)
K	0. 32	+ 0. 8. 11·78	2. 35	+ 0. 8. 29·49	1. 19	+ 0. 1. 23·66
M	0. 35	+ 0. 6. 58·02	2. 38	+ 0. 7. 13·03	1. 22	+ 0. 0. 5·40
R B	11. 15	+ 1. 30. 12·68	1. 17	+ 1. 30. 6·65	0. 4	+ 1. 22. 51·05
R M	3. 37	− 2. 53. 39·56	5. 40	− 2. 54. 34·14	4. 27	− 3. 2. 4·49
A A	0. 47	− 0. 0. 34·48	2. 49	− 0. 0. 39·29	1. 36	− 0. 7. 53·53
B B	10. 59	+ 1. 49. 53·60	1. 0	+ 1. 50. 1·93	11. 47	+ 1. 42. 51·72
C C	0. 49	+ 0. 0. 30·00	2. 51	+ 0. 0. 31·32	1. 38	− 0. 6. 41·40
D D	0. 51	− 0. 0. 29·36	2. 53	− 0. 0. 31·67	1. 42	− 0. 7. 45·64
E E	0. 52	+ 0. 0. 23·90	2. 53	+ 0. 0. 24·58	1. 42	− 0. 6. 48·30
F F	0. 53	+ 0. 0. 51·52	2. 54	+ 0. 0. 55·65	1. 44	− 0. 6. 16·23
G G	0. 53	+ 0. 2. 49·13	2. 54	+ 0. 2. 58·78	1. 44	− 0. 4. 10·09
U	9. 6	+ 3. 20. 54·07	11. 47	+ 3. 21. 21·84	10. 23	+ 3. 14. 16·70
V	9. 44	+ 2. 46. 4·53	0. 29	+ 2. 46. 36·75	11. 2	+ 2. 39. 34·23
W	10. 3	+ 2. 31. 19·31	0. 49	+ 2. 31. 47·39	11. 21	+ 2. 24. 42·57

Name of Chronometer.	WAIMEA, January 11, about 4h. p.m.		HONOLULU, January 12, about 3h. p.m.		HONOLULU, January 13, about 1h. p.m.	
	Chronometer Time.	Chronometer Slow on Waimea Mean Time.	Chronometer Time.	Chronometer Slow on Honolulu Mean Time.	Chronometer Time.	Chronometer Slow on Honolulu Mean Time.
	h m	h m s	h m	h m s	h m	h m s
A	3. 46	− 0. 11. 5·59	2. 40	− 0. 3. 53·26	0. 40	− 0. 3. 54·70
B	3. 54	− 0. 16. 43·17	2. 48	− 0. 9. 32·78	0. 48	− 0. 9. 35·88
C	3. 56	− 0. 17. 11·20	2. 49	− 0. 10. 0·78	0. 49	− 0. 10. 4·25
D	3. 40	+ 0. 0. 26·05	2. 33	+ 0. 7. 46·71	0. 48	+ 0. 7. 53·67
E	3. 56	− 0. 12. 51·99	2. 48	− 0. 5. 39·70	0. 49	− 0. 5. 41·09
F	3. 49	− 0. 4. 15·77	2. 41	+ 0. 3. 2·10	0. 41	+ 0. 3. 5·70
G	3. 53	− 0. 6. 18·20	2. 45	+ 0. 0. 57·42	0. 44	+ 0. 0. 58·96
H (Sid.)	23. 18	(− 0. 4. 19·50)	22. 13	(+ 0. 2. 54·48)	20. 16	(+ 0. 2. 53·98)
K	3. 49	+ 0. 1. 32·12	2. 40	+ 0. 8. 53·50	0. 39	+ 0. 9. 1·61
M	3. 53	+ 0. 0. 10·89	2. 43	+ 0. 7. 30·47	0. 42	+ 0. 7. 35·50
R B	2. 33	+ 1. 22. 48·50	1. 24	+ 1. 29. 59·85	11. 22	+ 1. 29. 57·91

TABLE XIV. (*concluded*).

Name of Chronometer.	Waimea, January 11, about 4h. p.m.		Honolulu, January 12, about 3h. p.m.		Honolulu, January 13, about 1h. p.m.	
	Chronometer Time.	Chronometer Slow on Waimea Mean Time.	Chronometer Time.	Chronometer Slow on Honolulu Mean Time.	Chronometer Time.	Chronometer Slow on Honolulu Mean Time.
	h m	h m s	h m	h m s	h m	h m s
R M	6. 57	− 3. 2. 24·66	5. 48	− 2. 55. 28·07	3. 47	− 2. 55. 44·62
A A	4. 6	− 0. 7. 56·12	2. 57	− 0. 0. 43·67	0. 55	− 0. 0. 45·00
B B	2. 17	+ 1. 42. 54·36	1. 8	+ 1. 50. 10·65	11. 5	+ 1. 50. 12·93
C C	4. 8	− 0. 6. 41·28	3. 0	+ 0. 0. 32·86	0. 56	+ 0. 0. 32·89
D D	4. 11	− 0. 7. 46·74	3. 4	− 0. 0. 33·60	0. 59	− 0. 0. 34·14
E E	4. 12	− 0. 6. 48·37	3. 5	+ 0. 0. 25·79	1. 0	+ 0. 0. 25·99
F F	4. 14	− 0. 6. 15·27	3. 4	+ 0. 0. 59·88	1. 1	+ 0. 1. 1·08
G G	4. 13	− 0. 4. 5·70	3. 5	+ 0. 3. 12·14	1. 0	+ 0. 3. 16·11
U	0. 34	+ 3. 14. 24·97	11. 33	+ 3. 21. 46·58	9. 15	+ 3. 21. 54·42
V	1. 14	+ 2. 39. 46·10	0. 14	+ 2. 47. 10·53	9. 52	+ 2. 47. 20·42
W	1. 33	+ 2. 24. 51·95	0. 31	+ 2. 32. 14·11	10. 13	+ 2. 32. 22·02

TABLE XV.—STATIONARY and TRAVELLING RATES of CHRONOMETERS and INFERRED DIFFERENCES of LONGITUDE.

Name of Chronometer.	Stationary Rate at Kailua, Dec. 7–9.	Travelling Rate, Dec. 5–10.	Apparent Difference of Longitude. Kailua, East of Honolulu.	Stationary Rate at Honolulu, Dec. 10–14.	Stationary Rate at Honolulu, Dec. 8–13.	Stationary Rate at Kailua, Dec. 15–17.	Travelling Rate, Dec. 14–18.	Apparent Difference of Longitude. Kailua, East of Honolulu.
	s	s	m s	s	s	s	s	m s
A					+ 0·21	+ 0·53	+ 0·53	7. 24·30
B					− 3·61	− 2·93	− 2·58	7. 24·77
C					− 3·83	− 3·75	− 3·71	7. 24·86
D					+ 6·90	+ 7·26	+ 7·06	7. 24·59
E	− 0·53	− 0·21	7. 24·55	− 0·71		− 0·50	− 0·48	7. 24·94
F	+ 5·34	+ 6·05	7. 23·91	+ 4·93		+ 5·23	+ 5·73	7. 24·44
G					+ 2·86	+ 3·73	+ 4·10	7. 24·40
H (Sid.)					+ 1·18	+ 1·15	+ 1·06	7. 24·94
K	+ 9·20	+ 9·81	7. 23·79	+ 9·16		+ 9·22	+ 9·48	7. 24·36
M	+ 7·40	+ 7·91	7. 23·58	+ 6·80		+ 7·35	+ 8·03	7. 24·20
R B						− 1·17	− 1·80	7. 25·09
R M						−16·38	−16·39	7. 24·59
A A						− 1·52	− 1·75	7. 24·67

Name of Chronometer.	Stationary Rate at Kailua, Dec. 7–9.	Travelling Rate, Dec. 5–10.	Apparent Difference of Longitude. Kailua, East of Honolulu.	Stationary Rate at Honolulu, Dec. 10–14.	Stationary Rate at Honolulu, Dec. 8–13.	Stationary Rate at Kailua, Dec. 15–17.	Travelling Rate, Dec. 14–18.	Apparent Difference of Longitude. Kailua, East of Honolulu.
	s	s	m s	s	s	s	s	m s
B B						+ 3·84	+ 3·95	7. 25·03
C C						+ 1·51	+ 1·20	7. 24·13
D D						+ 0·28	+ 0·59	7. 24·72
E E						+ 1·10	+ 1·26	7. 24·81
F F						+ 0·99	+ 0·60	7. 24·37
G G						+ 7·70	+ 8·21	7. 24·80
U	+ 9·94	+ 9·61	7. 25·05	+ 9·34		+ 8·52	+ 8·00	7. 24·27
V	+13·10	+12·98	7. 24·72	+12·49		+12·58	+12·78	7. 24·88
W	+ 9·35	+ 9·34	7. 25·04	+ 9·21		+ 9·04	+ 9·12	7. 24·95

Name of Chronometer.	Travelling Rate, Dec. 19–21.	Apparent Difference of Longitude. Waimea, West of Honolulu.	Travelling Rate, Dec. 22–24.	Apparent Difference of Longitude. Waimea, West of Honolulu.	Stationary Rate at Honolulu, Dec. 24–30.	Stationary Rate at Honolulu, Dec. 30–Jan. 2.	Stationary Rate at Kailua, Jan. 3–4.
	s	m s	s	m s	s	s	s
A	− 0·43	7. 13·37	− 0·99	7. 13·94	− 1·30	− 0·51	+ 0·14
B	− 3·33	7. 13·78	− 3·55	7. 13·39	− 3·44	− 3·45	− 3·33
C	− 3·65	7. 13·72	− 3·26	7. 13·35	− 3·68	− 4·07	− 3·57
D	+ 6·68	7. 13·84	+ 6·43	7. 12·80	+ 6·48	+ 7·17	+ 8·00
E	− 0·83	7. 14·01	− 1·00	7. 13·36	− 1·32	− 1·38	− 0·90
F	+ 5·22	7. 13·29	+ 4·87	7. 13·39	+ 4·14	+ 4·08	+ 5·00
G	+ 3·40	7. 13·52	+ 3·04	7. 13·37	+ 2·18	+ 2·44	+ 3·17
H (Sid.)	+ 1·52	7. 13·81	+ 1·66	7. 13·23	+ 1·55	+ 1·65	+ 1·30
K	+ 8·90	7. 13·30	+ 8·35	7. 13·14	+ 7·15	+ 7·86	+ 8·68
M	+ 7·41	7. 13·54	+ 6·78	7. 13·39	+ 5·18	+ 6·12	+ 7·10
R B	− 1·57	7. 13·66	− 1·46	7. 13·24	− 1·27	− 1·70	− 1·86
R M	−16·76	7. 13·44	−17·31	7. 13·10	−17·56	−17·53	−17·27
A A	− 1·54	7. 13·72	− 1·49	7. 13·43	− 1·97	− 1·75	− 1·00
B B	+ 3·46	7. 13·74	+ 3·12	7. 13·36	+ 2·94	+ 2·93	+ 3·18
C C	+ 1·89	7. 14·11	+ 0·59	7. 13·18	+ 0·66	+ 1·47	+ 2·21
D D	+ 0·11	7. 13·66	0·00	7. 13·40	− 0·34	− 0·57	+ 0·24
E E	+ 0·83	7. 13·71	+ 0·92	7. 13·46	+ 0·38	+ 0·59	+ 1·04
F F	+ 1·37	7. 13·64	+ 0·72	7. 12·96	+ 1·03	+ 2·39	+ 1·73
G G	+ 7·04	7. 13·72	+ 6·69	7. 13·05	+ 5·77	+ 6·57	+ 7·56
U	+ 7·92	7. 14·14	+ 8·09	7. 13·70	+ 8·52	+ 8·41	+ 8·26
V	+11·69	7. 13·90	+11·85	7. 13·39	+11·90	+11·94	+11·92
W	+ 9·00	7. 13·66	+ 8·90	7. 13·34	+ 8·93	+ 9·17	+ 9·42

TABLE XV.—RATES OF CHRONOMETERS AND INFERRED DIFFERENCES OF LONGITUDE (*concluded*).

Name of Chronometer.	Travelling Rate, Jan. 2–6.	Apparent Difference of Longitude. Kailua, East of Honolulu.	Stationary Rate at Honolulu, Jan. 6–9.	Average Rate, Jan. 9–12.	Apparent Difference of Longitude by the Comparisons at Waimea, Jan. 10.	Apparent Difference of Longitude by the Comparisons at Waimea, Jan. 11.	Stationary Rate at Honolulu, Jan. 12–13.
	s	m s	s	s	m s	m s	s
A	− 0·76	7. 25·03	− 1·73	− 1·41	7. 13·25*	7. 13·70*	− 1·57
B	− 3·41	7. 24·62	− 3·76	− 3·60	7. 13·42	7. 13·83	− 3·38
C	− 3·50	7. 24·58	− 3·29	− 3·32	7. 12·93	7. 13·59	− 3·79
D	+ 7·19	7. 24·49	+ 7·18	+ 7·48	7. 13·40	7. 13·57	+ 7·58
E	− 1·33	7. 24·67	− 1·42	− 1·39	7. 13·19	7. 13·62	− 1·53
F	+ 4·35	7. 25·17	+ 3·88	+ 4·32	7. 13·03	7. 13·74	+ 3·93
G	+ 2·77	7. 24·68	+ 1·62	+ 1·83	7. 12·97	7. 13·46	+ 1·68
H (Sid.)	+ 0·79	7. 24·92	+ 0·51	+ 0·28	7. 12·96	7. 13·72	− 0·54
K	+ 7·80	7. 25·19	+ 5·75	+ 8·00	7. 13·41	7. 13·80	+ 8·85
M	+ 6·72	7. 25·22	+ 4·87	+ 5·81	7. 13·14	7. 14·08	+ 5·48
R B	− 2·64	7. 24·73	− 1·96	− 2·26	7. 13·45	7. 13·53	− 2·11
R M	−17·83	7. 24·90	−17·67	−17·94	7. 13·31	7. 13·67	−18·05
A A	− 0·87	7. 25·08	− 1·40	− 1·45	7. 12·86	7. 13·85	− 1·45
B B	+ 2·77	7. 24·81	+ 2·70	+ 2·90	7. 12·96	7. 13·52	+ 2·48
C C	+ 1·04	7. 25·14	+ 0·43	+ 0·50	7. 13·20	7. 13·63	+ 0·03
D D	− 0·26	7. 24·77	− 0·75	− 0·64	7. 13·36	7. 13·76	− 0·58
E E	+ 0·81	7. 24·79	+ 0·22	+ 0·40	7. 13·26	7. 13·77	+ 0·22
F F	+ 1·41	7. 24·70	+ 1·34	+ 1·40	7. 13·28	7. 13·87	+ 1·31
G G	+ 6·39	7. 25·38	+ 3·13	+ 4·43	7. 13·30	7. 13·50	+ 4·34
U	+ 8·21	7. 24·54	+ 8·92	+ 8·28	7. 12·93	7. 13·70	+ 8·65
V	+11·57	7. 25·28	+10·35	+11·30	7. 13·14	7. 13·61	+10·97
W	+ 9·01	7. 24·84	+ 9·01	+ 8·94	7. 13·20	7. 13·58	+ 8·75

* Waimea, January 10 and 11. The mean has been used as a single determination.

TABLE XVI.—SPECIMEN of the REFLECTING CIRCLE OBSERVATIONS of the SUN at HONOLULU, 1875, March 9, and INFERRED ERROR of CHRONOMETER N.

Approximate Local Mean Time, Civil Reckoning.	Time by Sidereal Chronometer N.	Upper or Lower Limb of Sun.	Circle Backwards or Forwards.	Mean Circle Reading.	For Mean of Times. N. P. D. of the Sun and Equation of Time.	For Mean of Times. Refraction. Semidiameter. Parallax.	True Altitude of the Center.	Chronometer N Slow on Local *Mean* Time.
1875.	h m s			° ′ ″			° ′ ″	h m s
March 9,	19. 22. 4·2	U	B	54. 1. 20·0	° ′ ″	′ ″	26. 43. 0	+0. 52. 24·2
8h. 15m. A.M.	19. 23. 3·5			54. 27. 23·3	94. 25. 35·5	1. 46·8	26. 56. 2	23·4
	19. 23. 59·5			54. 52. 40·0	m s	16. 12·2	27. 8. 40	24·1
	19. 25. 8·5			55. 23. 13·3	+10. 42·45	8·0	27. 23. 57	23·7
	19. 26. 3·0			55. 47. 23·3			27. 36. 2	23·5
8h. 23m. A.M.	19. 28. 27·0	L	F	55. 47. 10·0	° ′ ″	′ ″	28. 8. 1	+0. 52. 23·2
	19. 29. 30·5			56. 15. 33·3	94. 25. 29·0	1. 42·65	28. 22. 13	23·7
	19. 30. 45·0			56. 48. 20·0	m s	16. 12·2	28. 38. 36	23·1
	19. 32. 6·8			57. 24. 33·3	+10. 42·38	8·0	28. 56. 43	23·0
	19. 33. 6·3			57. 50. 46·7			29. 9. 49	22·7
3h. 43m. P.M.	2. 49. 44·0	L	B	64. 29. 36·7	° ′ ″	′ ″	32. 29. 51	+0. 51. 13·2
	2. 51. 0·7			63. 56. 23·3	94. 18. 19·0	1. 28·6	32. 13. 15	12·4
	2. 51. 50·0			63. 34. 33·3	m s	16. 12·2	32. 2. 20	12·9
	2. 52. 33·0			63. 15. 46·7	+10. 37·68	8·0	31. 52. 56	12·8
	2. 53. 21·5			62. 54. 36·7			31. 42. 21	12·5
3h. 53m. P.M.	2. 59. 3·0	U	F	61. 30. 40·0	° ′ ″	′ ″	30. 27. 30	+0. 51. 11·6
	2. 59. 59·0			61. 5. 56·7	94. 18. 8·5	1. 34·8	30. 15. 8	11·7
	3. 1. 19·0			60. 30. 40·0	m s	16. 12·2	29. 57. 30	11·6
	3. 4. 0·0			59. 19. 33·3	+10. 37·57	8·0	29. 21. 57	11·4
	3. 6. 0·0			58. 26. 56·7			28. 55. 38	10·2

Index Correction of the Circle, +22″, Circle Backwards.
−22″, Circle Forwards.

	A.M.	P.M.
Barometer............	30·00	30·10
External Thermometer ..	69°·5	77°·0

Latitude, 21°. 17′. 58″.

Assumed Longitude, 10h. 31m. 14s. West.

Adopted N Slow on Local *Mean* Time, 1874, Dec. 9, near Noon, at 23h. 12m. 9s·2 by itself, +0h. 51m. 47s·75.

TABLE XVII.—ERRORS of CHRONOMETERS at HONOLULU before sailing for SAN FRANCISCO.

Name of Chronometer.	1875, March 7, near Noon.		March 8, near Noon.		March 9, near Noon.	
	Chronometer Time.	Chronometer Slow on Honolulu Mean Time.	Chronometer Time.	Chronometer Slow on Honolulu Mean Time.	Chronometer Time.	Chronometer Slow on Honolulu Mean Time.
	h m	h m s	h m	h m s	h m	h m s
A	0. 59	− 0. 4. 39·80	0. 31	− 0. 4. 39·86	0. 45	− 0. 4. 39·26
B	1. 8	− 0. 13. 10·15	0. 40	− 0. 13. 14·02	0. 54	− 0. 13. 17·41
C	1. 9	− 0. 13. 6·00	0. 40	− 0. 13. 9·45	0. 54	− 0. 13. 12·75
D	0. 42	+ 0. 14. 29·88	0. 13	+ 0. 14. 36·87	0. 27	+ 0. 14. 44·94
E	1. 4	− 0. 7. 6·65	0. 35	− 0. 7. 8·66	0. 49	− 0. 7. 9·81
F	0. 51	+ 0. 6. 41·85	0. 22	+ 0. 6. 45·60	0. 36	+ 0. 6. 50·45
G	0. 56	+ 0. 2. 42·44	0. 26	+ 0. 2. 44·62	0. 41	+ 0. 2. 47·89
L	0. 44	+ 0. 16. 4·45	0. 14	+ 0. 16. 3·14	0. 28	+ 0. 16. 2·92
O	0. 53	+ 0. 8. 40·36	0. 25	+ 0. 8. 42·07	0. 37	+ 0. 8. 43·94
Q	11. 50	+ 0. 1. 10·63	0. 0	+ 0. 1. 10·61	11. 55	+ 0. 1. 11·98
R	11. 36	+ 0. 16. 7·93	11. 45	+ 0. 16. 2·72	11. 38	+ 0. 15. 58·47
S	—	—	—	—	0. 50	− 0. 0. 45·55
V	0. 46	+ 0. 16. 22·26	0. 18	+ 0. 16. 31·38	0. 30	+ 0. 16. 41·07
W	10. 23	+ 2. 40. 24·66	9. 54	+ 2. 40. 33·34	10. 6	+ 2. 40. 43·24
R H	—	—	—	—	8. 30*	+ 5. 31. 19·34
R B	—	—	—	—	0. 37*	+ 1. 28. 37·64
R M	—	—	—	—	5. 22*	− 3. 11. 24·75
	h m s		h m s		h m s	
Sidereal. H	—	—	—	—	—	—
Sidereal. J	23. 30. 30	+ 1. 28. 43·89	23. 5. 0	+ 1. 24. 44·78	23. 23. 25	+ 1. 20. 39·05
Sidereal. N	22. 51. 59	+ 0. 59. 33·82	23. 6. 15	+ 0. 55. 40·21	23. 12. 9	+ 0. 51. 47·75

* About $2^h. 5^m.$ p.m.

	h m				h m s	h m s
March 10,	0. 20,	Honolulu Mean Time,	Chronometer	H,	11. 32. 30,	+ 0. 47. 15·79.
„	0. 25,	„	„	S,	0. 26,	− 0. 0. 46·31.
„	1. 0,	„	„	R H,	7. 28,	+ 5. 31. 24·65.
„	1. 6,	„	„	R B,	11. 37,	+ 1. 28. 36·20.
„	1. 11,	„	„	R M,	4. 23,	− 3. 11. 42·20.
March 15,	4. 22,	„	„	H,	3. 54. 35,	+ 0. 27. 0·82.
„	4. 28,	„	„	S,	4. 29,	− 0. 0. 46·92.

Name of Chronometer.	March 17, about 4 p.m.*		March 18, about 2 p.m.*		March 20, about 9 a.m.*	
	Chronometer Time.	Chronometer Slow on Honolulu Mean Time.	Chronometer Time.	Chronometer Slow on Honolulu Mean Time.	Chronometer Time.	Chronometer Slow on Honolulu Mean Time.
	h m	h m s	h m	h m s	h m	h m s
A	4. 8	− 0. 4. 36·85	1. 32	− 0. 4. 37·11	8. 44	− 0. 4. 36·89
B	4. 18	− 0. 13. 48·47	1. 42	− 0. 13. 52·35	8. 54	− 0. 13. 59·42
C	4. 18	− 0. 13. 39·34	1. 42	− 0. 13. 42·60	8. 54	− 0. 13. 48·56
D	3. 49	+ 0. 15. 46·23	1. 13	+ 0. 15. 52·63	8. 25	+ 0. 16. 6·24
E	4. 13	− 0. 7. 22·43	1. 37	− 0. 7. 24·06	8. 49	− 0. 7. 26·93
F	3. 59	+ 0. 7. 26·23	1. 33	+ 0. 7. 29·81	8. 34	+ 0. 7. 38·03
G	4. 3	+ 0. 3. 9·69	1. 27	+ 0. 3. 11·69	8. 39	+ 0. 3. 16·66
L	3. 52	+ 0. 15. 56·74	1. 16	+ 0. 15. 55·66	8. 28	+ 0. 15. 54·44
O	4. 0	+ 0. 9. 3·43	1. 24	+ 0. 9. 5·18	8. 37	+ 0. 9. 9·84
Q*	0. 6	+ 0. 1. 12·40	0. 12	+ 0. 1. 12·72	0. 0	+ 0. 1. 12·95
R*	11. 52	+ 0. 15. 20·47	11. 58	+ 0. 15. 15·20	11. 47	+ 0. 15. 5·46
S	4. 13	− 0. 0. 47·73	1. 37	− 0. 0. 48·12	8. 51	− 0. 0. 47·65
V	3. 52	+ 0. 17. 55·81	1. 16	+ 0. 18. 3·59	8. 29	+ 0. 18. 19·75
W	1. 28	+ 2. 41. 59·36	10. 52	+ 2. 42. 7·32	6. 5	+ 2. 42. 24·33
R H	7. 18†	+ 5. 32. 9·54	3. 53†	+ 5. 32. 14·75	0. 21†	+ 5. 32. 31·99
R B	11. 27†	+ 1. 28. 28·15	8. 2†	+ 1. 28. 26·36	4. 29†	+ 1. 28. 23·85
R M	4. 15†	− 3. 13. 38·26	0. 45†	− 3. 13. 52·78	9. 14†	− 3. 13. 32·05
	h m s		h m s		h m s	
Sidereal. H	3. 48. 0	+ 0. 19. 12·16	1. 15. 25	+ 0. 15. 42·32	8. 34. 30	+ 0. 8. 40·12
Sidereal. J	3. 20. 0	+ 0. 47. 35·35	0. 47. 35	+ 0. 43. 57·69	8. 7. 0	+ 0. 36. 39·38
Sidereal. N*	23. 46. 36	+ 0. 20. 49·87	23. 55. 43	+ 0. 16. 57·90	23. 47. 11	+ 0. 9. 16·84

* The Errors of N, R, and Q correspond more nearly to Noon.
† March 17, about 1^{h}. p.m. March 18, 9½^{h}. a.m. March 20, 6^{h}. p.m.

March 7 observations a.m. and p.m.
„ 8 „ a.m. and p.m.
„ 9 „ a.m. and p.m.
„ 10 „ a.m. only. Cloudy p.m.
„ 15 „ a.m. and p.m.
„ 16 „ a.m. only. Cloudy p.m.
„ 17 „ a.m. and p.m.
„ 18 „ a.m. and p.m.
„ 20 „ a.m. and p.m.

TABLE XVIII.—ERRORS of CHRONOMETERS at MARE ISLAND, SAN FRANCISCO, after the Voyage from HONOLULU.

Name of Chronometer.	1875, April 9, about 2 p.m.		April 10, about 3 p.m.		April 12, about 9 a.m.	
	Chronometer Time.	Chronometer Slow on Mare Island Mean Time.	Chronometer Time.	Chronometer Slow on Mare Island Mean Time.	Chronometer Time.	Chronometer Slow on Mare Island Mean Time.
	h m	h m s	h m	h m s	h m	h m s
A	11. 32	+ 2. 17. 36·49	0. 52	+ 2. 17. 35·16	6. 13	+ 2. 17. 33·90
B	11. 43	+ 2. 6. 49·49	1. 4	+ 2. 6. 43·65	6. 25	+ 2. 6. 35·92
C	11. 43	+ 2. 7. 51·10	1. 3	+ 2. 7. 49·32	6. 24	+ 2. 7. 45·78
D	11. 10	+ 2. 41. 7·86	0. 30	+ 2. 41. 16·45	5. 51	+ 2. 41. 31·86
E	11. 37	+ 2. 14. 43·05	0. 58	+ 2. 14. 41·84	6. 18	+ 2. 14. 40·19
F	11. 20	+ 2. 31. 46·77	0. 41	+ 2. 31. 50·00	6. 1	+ 2. 31. 56·62
G	11. 26	+ 2. 26. 22·66	0. 48	+ 2. 26. 24·06	6. 7	+ 2. 26. 28·28
L	11. 16	+ 2. 37. 59·30	0. 38	+ 2. 37. 57·42	5. 57	+ 2. 37. 55·69
O	11. 24	+ 2. 32. 6·51	0. 47	+ 2. 32. 7·55	6. 5	+ 2. 32. 10·17
Q	2. 0*	+ 2. 23. 53·33	9. 32†	+ 2. 23. 53·00	9. 39†	+ 2. 23. 49·70
R	1. 48*	+ 2. 35. 56·82	5. 26 1. 14	+ 2. 35. 53·35 + 2. 35. 51·21	—	—
S	11. 35	+ 2. 22. 3·31	0. 58	+ 2. 22. 4·27	6. 16	+ 2. 22. 3·77
V	11. 11	+ 2. 44. 19·92	0. 32	+ 2. 44. 30·22	5. 51	+ 2. 44. 48·10
W	8. 48	+ 5. 7. 51·49	10. 9	+ 5. 8. 0·55	3. 28	+ 5. 8. 16·24
R H	—	—	6. 34	+ 7. 56. 27·09	4. 6	+ 7. 56. 29·72
R B	—	—	10. 42	+ 3. 50. 24·66	8. 12	+ 3. 50. 20·25
R M	—	—	3. 32	− 0. 58. 14·91	1. 1	− 0. 58. 50·51
	h m s		h m s		h m s	
Sidereal H	0. 41. 20	+ 1. 12. 4·77	2. 6. 50	+ 1. 7. 55·62	7. 33. 5	+ 1. 1. 9·52
Sidereal J	0. 16. 40	+ 1. 37. 20·78	1. 42. 50	+ 1. 33. 1·98	7. 8. 50	+ 1. 26. 1·77
Sidereal N	3. 9. 38*	+ 1. 13. 34·67	22. 45. 42†	+ 1. 10. 24·07	23. 0. 10†	+ 1. 2. 37·72

April 9. Observations p.m. only. Cloudy morning.
April 10. Observations a.m. and p.m. The errors of R correspond respectively.
April 12. Observations a.m. and p.m. R was found to have run down.
April 15. Observations a.m. and p.m.

* About $4^h. 20^m$. p.m. † Near noon.

TABLE XVIII. (*concluded*).			TABLE XIX.—RATES of CHRONOMETERS and INFERRED DIFFERENCE of LONGITUDE between MARE ISLAND and HONOLULU.			
Name of Chronometer.	April 15, about 9 a.m. Chronometer Time.	April 15, about 9 a.m. Chronometer Slow on Mare Island Mean Time.	Average Rate at Honolulu, March 7 to March 20.	Average Rate at Mare Island, April 9 to April 15.	Adopted Travelling Rate.	Concluded Difference of Longitude. Mare Island, East of Honolulu.*
	h m	h m s	s	s	s	h m s
A	6. 7	+ 2. 17. 27·62	+ 0·260	− 1·421	− 0·580	2. 22. 25·49
B	6. 19	+ 2. 6. 21·83	− 3·829	− 4·679	− 4·254	13·96
C	6. 18	+ 2. 7. 39·63	− 3·301	− 2·018	− 2·660	32·78
D	5. 44	+ 2. 41. 56·93	+ 7·539	+ 8·623	+ 8·081	18·19
E	6. 12	+ 2. 14. 37·19	− 1·560	− 0·994	− 1·277	35·19
F	5. 55	+ 2. 32. 7·18	+ 4·394	+ 3·633	+ 4·013	47·99
G	6. 1	+ 2. 26. 32·96	+ 2·681	+ 1·967	+ 2·324	19·05
L	5. 51	+ 2. 37. 51·75	− 0·764	− 1·211	− 0·987	24·47
O	5. 58	+ 2. 32. 16·34	+ 2·326	+ 1·780	+ 2·053	15·24
Q	9. 45†	+ 2. 23. 41·60	+ 0·157	− 1·975	− 0·909	(60·68)
R	—	——	− 4·770	− 5·740	− 5·255	37·21
S	6. 9	+ 2. 22. 2·49	− 0·224	− 0·230	− 0·227	(56·85)
V	5. 44	+ 2. 45. 17·72	+ 9·205	+ 10·109	+ 9·657	44·87
W	3. 21	+ 5. 8. 43·29	+ 9·350	+ 9·024	+ 9·187	22·13
R H	0. 39	+ 7. 56. 32·16	+ 6·430	+ 0·990	+ 3·710	(41·83)
R B	4. 45	+ 3. 50. 13·38	− 1·225	− 2·380	− 1·802	38·79
R M	9. 35	− 0. 59. 44·04	− 16·740	− 18·730	− 17·735	26·23
	h m s		m s	m s	m s	
H	7. 38. 25	+ 0. 49. 22·29	− 3. 54·575	− 3. 55·310	− 3. 54·943	24·92
J	7. 14. 30	+ 1. 13. 50·30	− 4. 2·984	− 4. 3·525	− 4. 3·255	27·84
N	23. 8. 27†	+ 0. 50. 56·98	− 3. 51·445	− 3. 52·555	− 3. 52·000	2. 22. 11·23

Mean (rejecting Q, S, and R H) .... 2. 22. 28·2 ± 3·0. (h m s s)

* The absolute time at Honolulu, forming the starting point of the journey, is the mean of all the observations on March 17, 18, and 20 (about March 18, 9^h). The absolute time at Mare Island, forming the end of the journey, is the mean of the observations on April 9 and 10 (about April 9, 19^h). The travelling rate is therefore applied to an interval of 22 days 8 hours, approximately.

† Near noon.

TRANSIT OF VENUS, 1874.

PART I.

EXPEDITION TO THE HAWAIIAN ISLANDS

(*continued*).

Section 2.

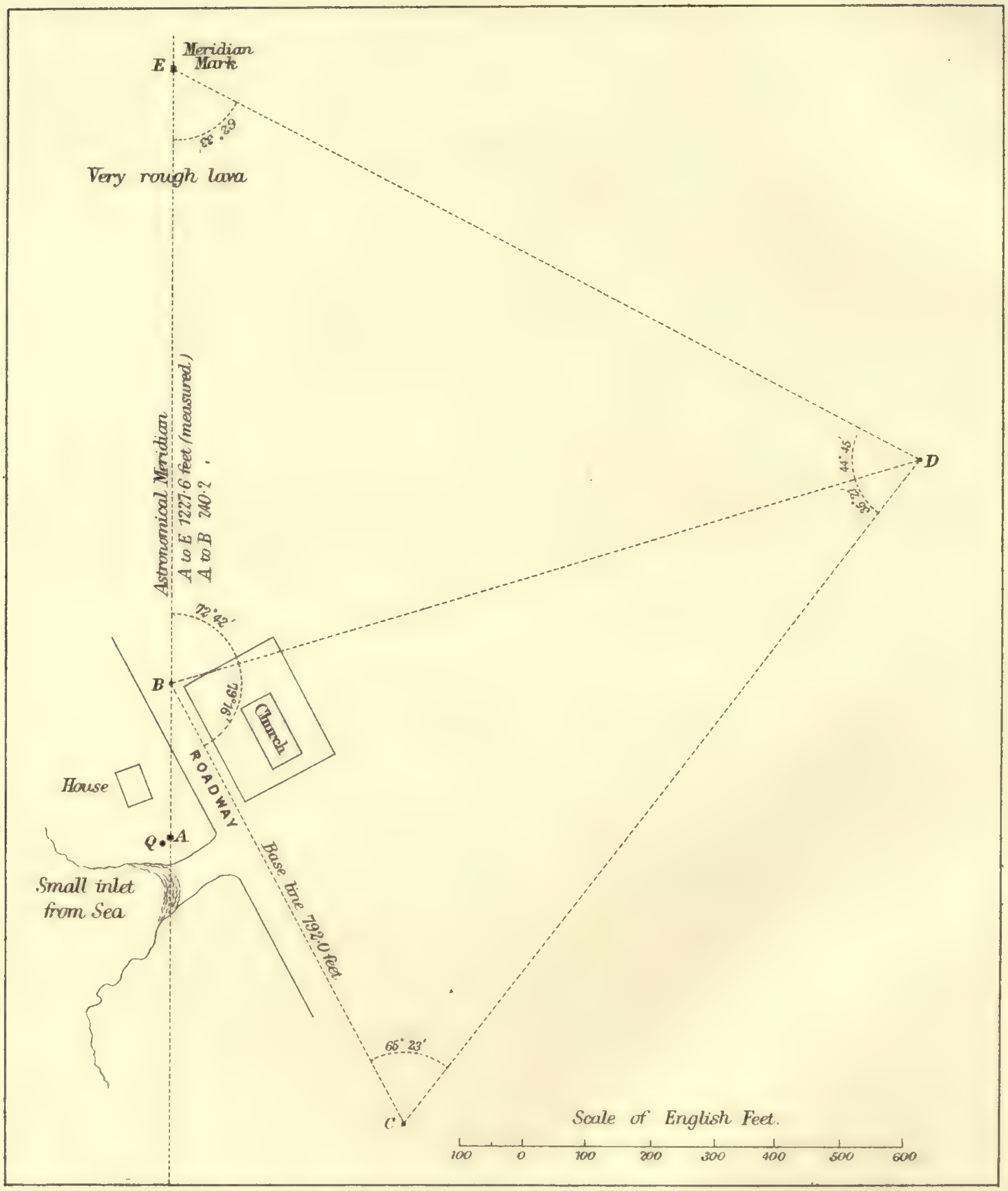
OBSERVATIONS AT KAILUA,

By Professor G. FORBES, F.R.S.E.

CONTENTS.

Transit of Venus 1874 Dec. 8.

Plan of the Station at Kailua, Island of Hawaii.



Reference A, the transit instrument.

Q, the Equatorial.

B, C, D, E, theodolite stations.

Dangerfield. Lith. 22. Bedford S^t Covent Garden.

OBSERVATIONS AT KAILUA, ISLAND OF HAWAII.

By PROFESSOR GEORGE FORBES, F.R.S.E.

HAVING selected KAILUA as his place of observation, Professor FORBES arrived there in H.M.S. *Scout*, Captain R. P. CATOR, R.N., from Honolulu, 1874, November 5. A commodious dwelling had been most kindly placed at his disposal by H.R.H. the Princess RUTH, who occasionally resided there herself, the grounds of which offered a suitable position for the instruments; and these were, for the most part, ready for use by November 15. The position of the observatories is shown in Plate VI.; the transit pier was 200 feet S.W. of the most southern corner of the stone church.

Professor Forbes undertook continuous observations for local time, and to obtain as many meridional transits of the Moon as possible during his stay. The Longitude of his station, however, was to depend upon the fundamental determination of the longitude of the station at Honolulu, with which it was to be connected by transportation of chronometers.

The Transit Clock was originally constructed by Earnshaw, for the Royal Observatory, Greenwich, many years ago. Its former gridiron pendulum was replaced by one of Messrs. E. Dent and Co.'s cylindrical zinc and steel pendulums, and it was otherwise put into good order by them. At Kailua it was mounted on a firm tripod pedestal of wood and iron, which stood upon pickets of 8-inch timber driven firmly into the ground, the floor of the observatory being cut away clear of them.

Professor Forbes was supplied with a fine transit instrument by Messrs. T. Cooke and Sons, which was kindly lent to the Astronomer Royal by WILLIAM GARNETT, Esq., of Bashall Lodge, Clitheroe.

The Transit Instrument, from its size and weight, could hardly be termed a "portable" instrument. The object-glass was $2\frac{3}{4}$ inches aperture and about 36 inches focal length. The axis was 21 inches long and of great strength. The stand was of cast iron, unusually massive, and, at Kailua, stood upon a brick pier, with firm foundations on solid rock. The commodious wooden observatory, 13 feet by 10, was built at Honolulu.

The eye-end of the telescope was furnished with a fixed system of nine vertical wires of spider's web and the usual pair of horizontal wires. There was no micrometer.

The *Equatorial intervals of the wires* were found from the whole of the observed transits as follows, the signs being those proper for Equatorial stars when the illuminating lamp was West:—

	′ ″		′ ″
Wire *a*	+ 5. 47·81	Wire *f*	— 1. 28·18
b	+ 4. 24·07	*g*	— 2. 55·55
c	+ 2. 53·34	*h*	— 4. 24·89
d	+ 1. 27·41	*k*	— 5. 52·68
e	0. 0·00		

The intervals of the wires *a*, *c*, *e*, *g*, and *k* depend partly upon 200 transits of clock stars and partly upon transits of close circumpolar stars; those of the remaining wires upon the circumpolar stars only.

The *Level Error* was determined by means of a large striding level, the bubble of which was graduated to single seconds by the makers. The accuracy of the graduation was tested by Messrs. Troughton and Simms before the instrument left England.

The correction to the level error on account of inequality of the pivots was found to be—

			″	
On 1874,	October	13,	— 1·00	with lamp West.
„	November	19,	— 0·99	„

On this latter day the correction was determined in three positions of the telescope, corresponding to 0°, 30°, and 60°, Zenith Distance, and found to be 0″·97, 0″·99, and 1″·02 respectively. The pivots were therefore sensibly circular.

It was found that the Level Error was disturbed by the heat conducted and radiated from the illuminating lamp. On December 3, Professor Forbes found that when the lamp was east it lowered the east pivot 5″ of arc. He generally removed the lamp before applying the striding level. The systematic discordance between the results for clock error obtained with the reversed positions of the instrument (*see* page 217) is probably due to this cause.

The Level was adjusted November 26 and December 22.

Table I. contains the determinations of the level error while the instrument was mounted at Kailua.

The *Error of Collimation* of the center wire was obtained from observations of Polaris on side wires and of the Meridian Mark on the center wire as follows, the sign being considered positive when it implies an additive correction to the observed time of transits of equatorial stars with the lamp West:—

	By Polaris.	By Mer. Mark.
	″	″
1874. Nov. 23	+ 8·9	—
28	+ 9·3	—
Dec. 1	+ 8·7	—
3	+ 8·4	—
4	+10·3	—
9	+ 9·8	—
11	+ 8·6	—
13	+ 6·2	—
17	+ 9·1	+12·1
18	+11·0	+11·7
19	—	+11·1
20	+10·4	+11·1
21	+10·2	+11·6
22	+ 8·4	—
1874. Dec. 24	—	+10·4
25	—	+ 9·5
26	—	+ 9·1
27	—	+ 9·1
28	—	+ 9·1
29	+ 8·5	+10·1
30	—	+ 9·1
31	+13·7	+11·7
1875. Jan. 1	—	+ 9·1
2	(−15·9)	+ 9·1
3	+ 9·1	+ 9·8
4	—	+ 9·1
12	—	+ 9·1

The value 9″·72 (+ for lamp West) has been used throughout the reductions.

The *Azimuth Error* depends generally upon the observation of a close circumpolar star; occasionally upon the Meridian Mark. This was placed upon a small brick pier on the ridge of a slight eminence to the north, unfortunately, owing to the nature of the ground, only 1,229 feet from the transit instrument. The mark itself was a copper plate perforated with a horizontal line of circular holes, sensibly equidistant, 1·875 inches apart, from center to center, every fifth hole being somewhat elongated in a vertical direction. In the field of view of the instrument, therefore, the distance between the holes from center to center subtended 26″·23. The mark was observed by daylight, and was rendered sufficiently distinct by placing a pasteboard diaphragm before the object-glass, having a vertical slit $\frac{3}{4}$ of an inch wide. The value of the intervals on the copper plate were also found from numerous observations of the position of side wires at the times when the center wire was usually observed. From these are obtained the following results:—

Wires.	Number of Intervals on the Copper Plate.	Number of Observations.	Adopted Interval of the Wires.	Value of one Interval on the Copper Plate.
	d		"	"
From *b* to *c*............	3·43	6	90·7	26·5
„ *c* to *d*............	3·31	9	85·9	26·0
„ *d* to *e*............	3·32	14	87·4	26·3
„ *e* to *f*............	3·43	14	88·2	25·7
„ *f* to *g*............	3·36	8	87·4	26·0
„ *g* to *h*............	3·41	7	89·3	26·2
			Mean....	26·1

The center of the mark was 76″·6 West of true North (Table III.).

When making an observation of the mark, the position of the wire on the image of the copper scale was estimated to the nearest tenth of a division; this was done with much greater accuracy than was to be expected.

When no close circumpolar star has been observed, the azimuth-error and clock-correction have been deduced from all the observed transits in the following manner:—

If x be the azimuth-error and y the clock-correction corresponding to the mean of the times,

$a = \frac{\text{Sin. Star's Z.D.}}{15 \text{ Sin. Stars N.P.D.}}$, (usually termed the "Azimuth-factor"),

$b =$ a quantity, in seconds of time, obtained by subtracting the star's apparent Right Ascension from the clock time of transit corrected for level and collimation, and, if necessary, for clock rate,

each star will give an equation of the form—

$$a\,x + y + b = 0.$$

Such equations have been solved by the method of least squares to obtain the most probable values of x and y.

In Table II. the extreme N.P.D.'s are given on each occasion of the employment of this method.

Tables II. and III. exhibit the observed and adopted Error of Azimuth, and the observations of the mark.

The Azimuth was adjusted November 24 and 26, December 18 and 31.

TRANSITS of STARS and of the MOON observed at KAILUA.

The description at page 15 of the stars observed at Honolulu, the method of reduction, and the arrangement of Table IV., applies to Kailua in every particular.

The places of Bradley 1730, 1731, 3058, and Groombridge 2053, which were occasionally observed for Azimuth Error, have been brought up from the Greenwich Catalogues for 1860 and 1864, and from the First Radcliffe Catalogue. Professor Forbes always observed clock stars on the five wires *a*, *c*, *e*, *g*, *k*. For complete transits the mean of the times has been reduced to the center wire by applying the correction $\frac{1^s \cdot 53}{15 \text{ Sin. N.P.D.}}$ additive with lamp East. Each wire of the imperfect transits has been reduced to the center wire by means of the intervals given at page 214. When a star has been observed on one side wire only the clock time recorded is given at the foot of the page.

The observations of circumpolar stars, with reversed positions of the transit axis, are separately reduced, and are occasionally very discordant; partly in consequence of the disturbing effect of the heat radiated from the illuminating lamp, and partly, occasionally at least, from an apparent liability of the Azimuth adjustment to be disturbed by the act of reversal, which was performed by the hands.

In the case of the Moon, the clock time of true transit over the Meridian has been corrected for the amount of the Moon's motion in R. A. corresponding to the sum of the instrumental corrections.

The transits selected for publication are those observed for chronometric connections, for the R. A. of the Moon's limb, and for the Ingress of Venus.

ERRORS and RATE of the TRANSIT-CLOCK at KAILUA.

When the means of the "clock slow" obtained from stars observed with lamp E. and lamp W. are separately taken, and the one reduced to the other by means of the rate, it is found that with lamp W. the clock is generally more slow than with lamp E. as follows:—

		s			s
1874.	December 1	+ 0·50	1874.	December 18	+ 0·12
	3	− 0·31		21	+ 0·38
	4	+ 0·25		22	+ 0·52
	6	+ 0·19		28	+ 0·40
	7	+ 0·14		29	+ 0·13
	9	+ 0·56		31	− 0·04
	11	+ 0·14	1875.	January 2	+ 0·42
	15	+ 0·24		3	+ 0·22
	16	+ 0·31		4	+ 0·20
	17	+ 0·44			

The mean of these is $+0^s \cdot 28$; December 3 and 31 are correctly reduced. On the few occasions when stars were observed with the instrument in one position only, one half of this quantity has been applied to the mean clock slow in Table V. The chronometric connection with Honolulu is, however, unaffected by them. The clock correction applied to the transit of the Moon is, of course, that proper to the position of the instrument.

MERIDIONAL TRANSITS of the MOON observed at KAILUA, and inferred LONGITUDE.

In Table IV. are given the clock time, properly corrected, of the passage of the Moon's limb over the true Meridian (affected, however, by diurnal aberration) and the clock correction at that instant. The following results have been obtained by interpolation, with fourth differences, from the section *Moon Culminating Stars* in the *Nautical Almanac*. The corrections to the Ephemeris are taken from the *Appendix*.

1874.	Limb of the Moon.	Observed R. A. of the Moon's Limb on the Meridian.	Longitude deduced from the Ephemeris.	Correction to the Ephemeris (ε).	Corrected Longitude.	Weight.
		h m s	h m s s	s	h m s	
November 23	II.	4. 41. 34·54	10. 23. 44·36 − 21·13 ε	− 0·74	10. 24. 0·0	1
24	II.	5. 50. 16·52	10. 23. 48·92 − 20·91 ε	− 0·80	10. 24. 5·7	1
26	II.	8. 2. 19·83	10. 23. 41·32 − 23·44 ε	− 0·84	10. 24. 1·0	1
December 15	I.	23. 25. 47·16	10. 23. 50·90 − 28·40 ε	− 0·36	10. 24. 1·1	½*
17	I.	1. 8. 34·30	10. 23. 45·60 − 27·19 ε	− 0·43	10. 23. 57·3	1
21	I.	5. 11. 16·63	10. 23. 40·91 − 21·20 ε	− 0·70	10. 23. 55·8	1
22	II.	6. 22. 31·65	10. 23. 37·90 − 21·03 ε	− 0·79	10. 23. 54·5	½*
			Mean for ☽ I.		10. 23. 57·5	
			„ ☽ II.		10. 24. 1·3	
			Apparent Longitude		10. 23. 59·4	

* On December 15 and 22 stars were not observed at the same time as the Moon.

Professor Forbes' station was also connected with the head station at Honolulu by transportation of chronometers. This work has been given in sufficient detail in the preceding account of operations at Honolulu.† The difference of longitude between the transit piers of the two stations was found to be $7^m. 24^s \cdot 64$. The adopted longitude of the Transit Pier at Honolulu is

† Chronometric connections, p. 30, and Tables XII. to XV., Honolulu Section.

$10^h. 31^m. 26^s{\cdot}3$ West of Greenwich. Hence the longitude of the Transit Pier at Kailua is $10^h. 24^m. 1^s{\cdot}7$ West of Greenwich.

LATITUDE of KAILUA.

The instrument used by Professor Forbes for the determination of the approximate latitude of his station was a repeating reflecting circle by Troughton and Simms, kindly lent by the Royal Astronomical Society.

Professor Forbes says: "In practice I never used this instrument as a "repeating circle, but simply as an improved form of sextant; the double "verniers giving greater accuracy and eliminating error of centering, the "power of moving the circle bodily being used as a means of varying the "zero-reading. Observations were made only on the Sun about noon. "Previous to a set of observations contacts were made with the limbs of the "two images of the Sun in the same manner as the readings 'off the arc' "and 'on the arc' are made with a sextant. This gave the zero-reading "and also a check-observation of the Sun's diameter. Eight or ten observa-"tions of the Sun's double altitude, as reflected from mercury, were made on "each occasion, Lieutenant Noble taking time by the Transit-Clock, or from "a chronometer which was compared with the clock."

From these observations the latitude appears to be 19°. 38′·4 North.

REPORT of PROFESSOR GEORGE FORBES on his OBSERVATIONS of the INGRESS of VENUS, 1874, December 8.

Operations at KAILUA, 1874, December 8.

H.M.S. *Tenedos*, Captain FRED. VAN DER MEULEN, arrived on December 7. Comparisons were made between the Transit-Clock and some chronometers brought for a preliminary longitude-run.

Captain VAN DER MEULEN told off some officers to take time and assist in the observations; Lieutenant H. C. BIGGE had been staying at Kailua some time, and the most responsible work was allotted to him. The driving clock of the large Equatoreal was a very imperfect arrangement. It was so irregular in its action (after all care had been taken to make its parts work easily) that it was necessary to have some one well fitted for the work to accelerate or retard the motion slightly, and gently, and to re-connect the clock-work. Mr. Bigge accomplished this admirably. He also attended to the sunshade, clamps, &c.

Mr. J. M. LLOYD, Navigating Lieutenant, was appointed to take time for me. The instruments were so arranged that at the time of actual observation it should be possible for a person stationed at the Transit-Clock to record time for an observer at the Equatoreal.

Eight marines were told off, four at a time, under the command of a sergeant, to keep silence during the time of observation. A native was supplied by Mr. KAAI to act as interpreter to the marines in case of necessity. To each of the marines was given a certain space to watch and to prevent the natives from approaching too near. Captain VAN DER MEULEN was exceedingly anxious to render all possible assistance.

Everything appeared to be most favourable until about 2 P.M. on December 8, when clouds began to drift from the mountains towards the sea. The natives crowded in hundreds at a short distance to watch our proceedings, but in no way whatever did they disturb us. An hour before the predicted time the adjustments and motions were examined and found to be in good order. The micrometer and eye-pieces could be interchanged easily in 15 seconds.

Time by the Transit-Clock. h s	
20. 21.	Clouds obscured the Sun. They continued off and on for some time.
20. 30.	Clouds still continue. I have almost given up hopes of using the double image micrometer before internal contact on account of the clouds. Airy's eye-piece is inserted with a graduated neutral tint glass.
20. 34.	Clouds off. Planet nearly half way on. Limbs of Sun and Venus boiling badly.
20. 38. 30.	Planet more than half way on, seen through thin clouds without the dark glass. Limbs of Sun and Venus sharp. "Silence" called.
20. 41.	Clearer. Tried micrometer. Clouds immediately came over. Changed to Airy's eye-piece.
20. 48. 50.	The edge of Venus outside the limb of the Sun was shown by a fine line of light, not visible quite all round, (and therefore, more correctly speaking, it was shown by *two* fine lines of light). The thread of light at the north cusp was longer than the other.

Time by the Transit-Clock.	
h m s	
20. 50.	Mr. Lloyd began to count seconds aloud from inside the transit-hut, but the Sun became obscured by clouds.
21. 8.	The planet is well on. The clouds are partially dispersed. The double-image-micrometer inserted; the following distances of limbs measured:—

h m s	r	h m s	r
21. 9. 30	21·005	21. 14. 11	20·345
10. 10	20·800	14. 56	20·154
11. 31	20·652	15. 23	20·209
12. 23	20·568	16. 40	20·029
13. 5	20·313	45*	19·866
13. 43	20·486	19. 14	19·756

* Minute not recorded.

The measures of distances of limbs were discontinued when that distance was about equal to the diameter of Venus, as shown by the overlapping of the two images of Venus.

So far as I can judge, the observations are sufficiently regular to lead to the belief that the micrometer was working well, in spite of a fall it had previously.

Measures are now taken of the diameter of Venus, to serve as a measure of one revolution of the micrometer-screw, and to determine the zero reading.

Micrometer Readings.
r
19·015
18·961
18·939

Considerable boiling. Images cannot be made equally bright by means of the adjusting screw.

Images made equally bright by revolving the body of the micrometer.

Micrometer Readings.
r
19·033
18·999
19·055

Readings were now taken with the opposite edges of the images in contact. Boiling of limbs very bad.

Micrometer Readings.
r
26·872
26·993
26·990
26·952

G. FORBES.

The Equatorial Telescope, its mounting and driving clock, which were purchased by the Government from R. Hodgson, Esq., were almost the counterpart of the "Bedford" Equatoreal, described by Admiral Smyth in the *Cycle of Celestial Objects.*

The object-glass, supposed to be by Cauchoix, was six inches in diameter, but the effective aperture was 5·7 inches, and the focal length was 75 inches. Professor Forbes describes its defining power as admirable.

At Kailua the long polar axis was supported by a massive framework of timber, which had been constructed at Greenwich, and adapted very nearly to the requisite latitude. The instrument was used in the open air, and when out of use was protected by a large tarpaulin.

The double-image-micrometer and solar diagonal reflector were made by Messrs. Troughton and Simms; the former was kindly lent to the Astronomer Royal by J. G. BARCLAY, Esq., of Leyton, Essex. It was accidentally injured by a fall just before the transit of Venus; the injury, however, appeared to be confined to the outer portion of the screw which carried the milled head (Plate III.).

It is unfortunate that all Professor Forbes' micrometer readings for distance of limbs were on one side of zero. He states also that the images could not be made equally bright, by means of the adjusting screw, without rotating the body of the micrometer; a circumstance which tends still farther to diminish the value of the measures.

The only clue to the zero reading of the micrometer, before it was rotated, is the first set of three readings for the diameter of the planet, the mean of which is $18^{r}·972$. After rotation the next set of three gives $19^{r}·029$, showing an apparent increase of the zero reading of ·057. The zero obtained

from the second and third sets is $22^{r}\cdot990$; hence the zero proper to apply to the readings for distance of limbs is $22\cdot990 - \cdot057 = 22^{r}\cdot933$.

Using the tabular semidiameter of Venus as before, we have for the value of one revolution of the micrometer screw—

$$\rho = \frac{31''\cdot42 + \delta r}{\frac{1}{4}(26\cdot952 - 19\cdot029)} = 15''\cdot863 + \cdot505\,\delta r.$$

The following equations have been formed with the values $\rho = 15''\cdot863 + \cdot505\,\delta r$; $R = 976''\cdot80$; $r = 31''\cdot42$; and assuming the latitude and longitude to be 19°. 38′. 23″ N., and $10^{h}.\ 24^{m}.\ 2^{s}\cdot7$ West, respectively. The revised longitude being $10^{h}.\ 24^{m}.\ 1^{s}\cdot7$ W., $\delta t = -1^{s}\cdot0$ on this account. The correction to the Transit-Clock has been assumed to be $+32^{s}\cdot03$.

G. L. T.

EQUATIONS of DISTANCE of CENTERS of the SUN and VENUS resulting from PROFESSOR FORBES' MICROMETRIC OBSERVATIONS, near INTERNAL CONTACT, with the 6-INCH EQUATOREAL at KAILUA.

Latitude, 19°. 38′. 23″ N. Assumed Longitude, $10^h. 24^m. 2^s{\cdot}7$ West of Greenwich.

Recorded Time by Transit-Clock.	Greenwich Sidereal Time.	Tabular Distance of Centers.	Micrometer Measures.	Distance of Near Limbs.	Resulting Equation.				
h. m. s.	h. m. s.	′ ″	r	″	″ ″			″	
21. 9. 30	7. 34. 4·7	15. 6·05	1·928	30·58 + 0·974 δr	+ 8·75 = − ·2248 n	+ ·6095 δR. A.	− ·7506 δN. P. D.	− ·0304 δt − δR	+ 1·974 δr
10. 10	34. 44·7	4·82	2·133	33·84 + 1·077	6·72 = − ·2246 n	+ 6076	·7524	·0303	2·077
11. 31	36. 5·7	2·22	2·281	36·18 + 1·152	6·98 = − ·2243 n	+ 6036	·7562	·0300	2·152
12. 23	36. 57·7	15. 0·79	2·365	37·52 + 1·194	7·07 = − ·2240 n	+ ·6012	·7584	·0298	2·194
13. 5	37. 39·7	14. 59·54	2·620	41·56 + 1·323	4·28 = − ·2238 n	+ ·5991	·7603	·0296	2·323
13. 43	38. 17·7	58·46	2·447	38·82 + 1·236	8·10 = − ·2232 n	+ 5972	·7621	·0287	2·236
14. 11	38. 45·7	57·57	2·588	41·05 + 1·307	6·96 = − ·2235 n	+ 5959	·7633	·0293	2·307
14. 56	39. 30·7	56·24	2·779	44·08 + 1·403	5·06 = − ·2233 n	+ 5937	·7653	·0297	2·403
15. 23	39. 57·7	55·46	2·724	43·21 + 1·376	6·71 = − ·2231 n	+ ·5924	·7666	·0291	2·376
16. 40	41. 14·7	53·24	2·904	46·07 + 1·467	6·07 = − ·2226 n	+ ·5885	·7700	·0279	2·467
(17.) 45	42. 19·7	51·37	3·067	48·65 + 1·539	5·36 = − ·2223 n	+ 5853	·7729	·0290	2·539
21. 19. 14	7. 43. 48·7	14. 48·83	3·177	50·40 + 1·594 δr	+ 6·15 = − ·2218 n	+ ·5807 δR. A.	− ·7769 δN. P. D.	− ·0278 δt − δR	+ 2·594 δr

Sun's Equatoreal Horizontal Parallax $= 8''{\cdot}950\left(1+\frac{n}{100}\right)$.

TABLE I.—LEVEL ERROR of the TRANSIT INSTRUMENT at KAILUA, determined by SPIRIT LEVEL.

The sign + indicates that the East Pivot is low.

Day.	Sidereal Time of Level Determination.	Position of Lamp.	Level Error corrected for Inequality of Pivots.
1874.	h m		″
November 23	22. 50	E	+ 7·90
	23. 0	E	+ 8·05
	23. 20	E	+ 8·10
	1. 5	W	+ 9·28
	1. 50	W	+ 9·20
	3. 40	W	+ 9·52
	4. 44	W	+ 9·60
	5. 21	W	+ 9·52
24	1. 4	W	+ 9·85
	1. 45	W	+ 9·78
	2. 4	W	+ 9·95
	4. 30	W	+ 8·73
	5. 55	W	+ 9·40
26	6. 25	W	+ 10·93
	6. 45	W	+ 9·93
	7. 30	W	+ 10·55
	8. 5	W	+ 11·80
28	0. 10	W	+ 12·15
	0. 30	W	+ 12·12
	1. 0	W	+ 12·22
30	0. 30	E	+ 11·28
	0. 45	E	+ 11·28
	1. 30	E	+ 10·85
December 1	0. 40	E	+ 10·93
	1. 5	E	+ 10·58
	1. 30	W	+ 12·63
	1. 50	W	+ 12·13
2	0. 25	W	+ 12·13

Day.	Sidereal Time of Level Determination.	Position of Lamp.	Level Error corrected for Inequality of Pivots.
1874.	h m		″
December 3	1. 5	E	+ 10·78
	1. 25	W	+ 12·88
	2. 15	W	+ 11·28
	3. 55	E	+ 12·28
	4. 10	E	+ 12·15
	4. 30	E	+ 17·53*
4	0. 5	E	+ 12·08
	0. 25	E	+ 12·50
	0. 40	E	+ 11·93
	1. 10	E	+ 11·90
	2. 25	W	+ 13·88
	2. 55	W	+ 13·70
6	4. 15	W	+ 14·35
	4. 30	W	+ 13·65
	4. 45	E	+ 12·70
	5. 0	E	+ 12·55
7	2. 40	E	+ 11·83
	3. 55	E	+ 11·73
	4. 42	W	+ 13·15
9	0. 45	W	+ 13·85
	1. 5	W	+ 14·43
	1. 23	E	+ 12·73
	1. 50	E	+ 12·50
	2. 13	E	+ 11·95
	2. 30	E	+ 12·88
11	1. 10	E	+ 11·83
	1. 22	W	+ 13·88
	1. 50	W	+ 13·53

* Lamp left on; for the other readings it had been removed.

Day.	Sidereal Time of Level Determination.	Position of Lamp.	Level Error corrected for Inequality of Pivots.	Day.	Sidereal Time of Level Determination.	Position of Lamp.	Level Error corrected for Inequality of Pivots.
1874.	h m		"	1874.	h m		"
December 13	1. 10	W	+ 15·05	December 29	1. 10	W	+ 12·68
	1. 26	E	+ 15·38		1. 20	E	+ 10·15
	1. 50	E	+ 16·20		2. 22	W	+ 12·75
					12. 45	W	+ 12·75
14	0. 45	E	+ 13·05				
	1. 12	E	+ 13·17	30	13. 28	W	+ 12·00
15	23. 30	E	+ 12·40				
	4. 20	E	+ 12·62	31	1. 0	E	+ 10·03
	5. 50	W	+ 14·20		1. 25	W	+ 12·35
					13. 0	W	+ 11·10
16	10. 30	W	+ 14·55				
	11. 0	E	+ 13·70	1875.			
				January 1	22. 45	E	+ 10·78
17	1. 5	W	+ 14·72		4. 5	E	+ 8·53
	1. 30	E	+ 12·95		15. 0	W	+ 10·08
	3. 18	E	+ 13·10				
	3. 55	W	+ 15·52	2	1. 9	W	+ 9·65
					1. 23	E	+ 8·83
18	1. 10	W	+ 16·15		2. 40	W	+ 10·60
	1. 25	E	+ 15·05		16. 3	E	+ 7·35
20	0. 52	E	+ 15·55	3	1. 5	W	+ 10·25
	1. 22	W	+ 16·75		1. 30	E	+ 8·65
					17. 30	E	+ 8·05
21	1. 5	E	+ 14·93				
	1. 25	W	+ 16·73				
	5. 30	E	+ 16·38	4	5. 35	E	+ 10·13
					6. 14	W	+ 13·18
22	0. 52	E	+ 10·63				
	1. 27	W	+ 11·73	12	0. 40	E	+ 11·60
	6. 25	E	+ 11·05				
				13	5. 45	E	+ 10·83
28	2. 16	E	+ 11·18				
	2. 47	W	+ 12·20	19	3. 45	E	+ 11·55
	15. 30	E	+ 10·18				

TABLE II.—AZIMUTH ERROR of the TRANSIT INSTRUMENT at KAILUA.

[The sign + indicates that the East Pivot is too far North.]

Day and Approximate Mean Time.		Stars used for Azimuth Error. The letters (E, W) refer to the Position of the Lamp.	Azimuth Error By Stars.	By Meridian Mark.	Adopted.
1874.	h		"	"	"
November 23	9	Polaris (E, W) and ν Piscium	− 37·2	—	− 37·5
24	9	Polaris (W) and θ Ceti	− 36·4	—	− 36·4
26	14	γ Geminorum, Sirius, ε Canis Majoris	− 52·1	—	− 52·1
26	15½	λ Ursæ Minoris S.P. (W) assuming the clock correction + 9ˢ·15	− 35·3	—	− 35·3
28	9	Polaris (W, E) and Bradley 1730 S.P. (W)	− 21·7	—	− 21·9
		" " 1731 S.P. (W)	− 22·2	—	
30	8	6 Stars between N.P.D. 63° and 109°	− 18·0	—	− 21·3
December 1	8½	Polaris (E, W) and β Ceti	− 20·7	—	− 20·7
2		——	—	—	− 19·0
3	8½	Polaris (E, W) and Piscium	− 17·2	—	− 17·2
4	8½	Polaris (E, W) and ν Piscium	− 5·1	—	− 4·9
	9	Groombridge 2053 S.P. (W) and 69 Ceti	− 3·9	—	
6	12	6 Stars between N.P.D. 57° and 113°	− 14·4	—	− 14·4
7	11	8 Stars between N.P.D. 59° and 106°	− 5·0	—	− 5·7
9	8	Polaris (E, W) and ν Piscium	− 6·2	—	− 6·2
11	8	Polaris (E, W) and ε Piscium	− 7·0	—	− 7·0
13	8	Polaris (W) and β Andromedæ (W)	− 2·8	—	− 2·8
	8	Polaris (E) and ο Piscium (E)*	− 11·9	—	− 11·9
14		——	—	—	− 14·4
15	13	δ Ursæ Minoris S.P. (W) and α Orionis	− 16·8	—	− 16·9
	13	24 Ursæ Minoris S.P. (W) and α Orionis	− 17·1	—	
16	17	9 Stars between N.P.D. − 6° and 109°	− 10·8	—	− 12·7
17	8	Polaris (W) and 53 Arietis	− 16·5	− 16·3	17·8
	8	Polaris (E) and 31 Tauri	− 18·0	—	
	9	θ Ursæ Minoris S.P. (W) and 31 Tauri	− 18·0	—	
18	5	——	—	− 16·3	—
18	7½	Polaris (E, W) and Bradley 1731 S.P. (W)	+ 45·5	+ 44·0	+ 45·5
19	5	——	—	+ 47·3	—
20	7	Polaris (E, W), Bradley 1731 S.P. (E)	+ 45·2	+ 44·6	+ 45·3
21	7	Polaris (E, W), Groombridge 2053 S.P. (W)	+ 46·0	+ 44·0	+ 46·0
22	7	Polaris (E, W), Bradley 1731 S.P. (E)	+ 43·0	—	+ 43·0
27	5	——	—	+ 46·6	—

* Azimuth disturbed by act of reversal.

Day and Approximate Mean Time.			Stars used for Azimuth Error. The letters (E, W) refer to the Position of the Lamp.	Azimuth Error		
				By Stars.	By Meridian Mark.	Adopted.
1874.		h		"	"	"
December	28	8	11 Stars between N.P.D. 67° and 106°	+ 50·8	+ 46·6	+ 44·3
	29	7	Polaris (W, E), Groombridge 2053 S.P. (E)	+ 44·3	+ 46·0	+ 44·3
	30	19	——	—	+ 47·9	—
	31	5½	——	—	− 10·8	—
		7	Bradley 1731 S.P. (E), α Eridani	− 14·0	—	
		7	Polaris (E), α Eridani	− 13·0	—	− 16·3
		7	Polaris (W), α Eridani*	− 21·7	—	
1875.						
January	1	4	——	—	− 23·9	—
		9	7 Stars between N.P.D. 71° and 115°	− 29·0	—	− 26·6
		20	——	—	− 21·3	—
	2	7	Polaris (W) and θ Arietis	− 24·5	—	
		7	Polaris (E) and ο Piscium*	− 11·4	—	− 11·3
		8	Groombridge 2053 S.P. (E) and 62 Ceti	− 10·1	—	
		21	——	—	− 6·9	—
	3	5	——	—	− 10·8	—
		6	Polaris (W), clock $+20^s·97$	− 9·6	—	
		6	Polaris (E), „ $+20^s·76$	− 10·9	—	− 10·2
		8	β Ursæ Minoris S.P. (W), „ $+21^s·07$	− 6·1	—	
		22	——	—	− 5·6	—
	4	9	ε Ursæ Minoris S.P. (E), 31 Orionis	− 4·7	—	
		9	Piazzi IV. 317 (E), 31 Orionis	− 6·6	—	− 3·1
		10	δ Ursæ Minoris S.P. (W), η Geminorum	− 1·4	—	
		10	δ Ursæ Minoris S.P. (E), 31 Orionis	− 7·8	—	
		19	Lamp E before reversal	—	− 8·2	—
		19	Lamp W after reversal*	—	+ 44·0	—
	12	5	——	—	+ 49·2	—
	13	8	5 Stars between N.P.D. 11° and 87°	+ 44·0	—	+ 44·0
	19	9	4 Stars between N.P.D. 71° and 104°	+ 37·5	—	+ 37·9

* The act of reversal evidently disturbed the Azimuth on these occasions.

TABLE III.—OBSERVATIONS of the MERIDIAN MARK at KAILUA, and its CONCLUDED AZIMUTH.

Day and Approximate Mean Time.			Center Wire apparently *Left* of Center of Image of Copper Scale. Lamp E.	Lamp W.	Center of Mark West of Optic Axis.	Azimuth Error, as determined by Stars.	Center of Mark apparently West of North.
1874.		h	div.	div.	″	″	″
December	17	4½	+ 3·1	+ 4·05	+ 93·3	− 17·3	+ 76·0
	18	5½	+ 3·1	+ 4·0	+ 92·7	——	——
		5½	+ 0·8	+ 1·7	+ 32·6	+ 45·5	+ 78·1
	19	5	0·7	1·55	29·3	——	——
	20	5	0·8	1·65	32·0	+ 45·3	+ 77·3
	21	5½	0·8	1·7	32·6	+ 46·0	+ 78·6
	24	Noon	0·95	1·75	35·2	——	——
		22½	1·0	1·75	35·8	——	——
	25	5	1·[illegible]	1·7	35·2	——	——
		21½	1·0	1·7	35·2	——	——
	27	5	0·8	1·5	30·0	——	——
	28	5	0·8	1·5	30·0	——	——
		21	0·8	1·5	30·0	——	——
	29	5	0·75	1·6	30·6	+ 44·3	+ 74·9
	30	19	+ 0·75	+ 1·45	+ 28·7	——	——
		19½	+ 2·8	+ 3·7	+ 84·8	——	——
	31	5½	2·9	3·8	87·4	− 13·0	+ 74·4
1875.							
January	1	4	3·5	4·2	100·5	——	——
		20	3·4	4·1	97·9	——	——
	2	21	2·8	3·6	83·5	− 11·3 (?)	+ 72·2 (?)
	3	5	3·0	3·7	87·4	− 10·2	+ 77·2
		22	2·8	3·5	82·2	− 7·0 (?)	+ 75·2 (?)
	4	19	2·9	1·6	{ 84·8 / 32·6 }	——	——
	12	5	+ 0·7	+ 1·4	+ 27·4	——	——

The adopted Azimuth of the Center of the Meridian Mark is 76″·6 West of North, and the adopted Value of One Interval on the Copper Scale, 26″·2.

TABLE IV.—TRANSITS of STARS and of the MOON observed at KAILUA, by Professor G. FORBES.

Day.		Position of the Illuminating Lamp.	Object observed and (Number of Wires).	Mean observed Clock-Time of Transit over the Center Wire.	Seconds of True Transit over the Meridian.	Seconds of Star's Assumed Apparent R.A.	Clock apparently Slow.
1874.				h m s	m s	s	s
November	23	E	γ Piscium	23. 10. 23·24	22·35	40·54	+ 18·19
			κ Piscium	23. 20. 13·58	12·61	31·00	18·39
			ι Piscium............	23. 33. 13·34	12·57	30·83	18·26
			Polaris (4)	1. 11. 33·79	12. 53·27	12·52	19·25
		W	Polaris (4)	1. 10. 42·46	12. 58·03	12·52	14·49
			ν Piscium	1. 34. 35·50	36·11	55·77	19·66
			α Arietis	1. 59. 46·23	47·75	7·90	20·15
			67 Ceti	2. 10. 25·07	25·16	45·33	+ 20·17
		W	ε Tauri	4. 20. 59·39	0·70	19·51	+ 18·81
			Aldebaran............	4. 28. 25·49	26·68	45·37	18·69
			Moon II..............	4. 41. 14·09	15·93	....	[18·63]
			ε Leporis.............	4. 59. 53·05	52·52	11·01	18·49
			Rigel	5. 8. 13·96	14·06	32·41	18·35
			β Tauri	5. 18. 3·72	5·63	23·88	18·25
	24	W	Polaris (1)	1. 10. 54·	13. 6·98	12·08	5·10
			θ Ceti................	1. 17. 41·62	41·69	46·76	5·07
			η Piscium	1. 24. 41·47	42·57	47·82	5·25
			ν Piscium............	1. 34. 50·12	50·77	55·77	+ 5·00
		W	α Arietis	2. 0. 2·47	4·01	7·90	+ 3·89
			67 Ceti...............	2. 10. 41·24	41·38	45·33	3·95
			Aldebaran............	4. 28. 40·09	41·30	45·38	4·08
			ι Aurigæ	4. 48. 45·20	47·36	51·75	4·39
			Capella	5. 7. 20·33	23·65	28·02	4·37
			δ Orionis	5. 25. 33·10	33·55	37·74	4·19
			α Columbæ	5. 35. 5·56	4·43	8·49	4·06
			Moon II..............	5. 50. 10·19	12·14	....	[4·38]
	26	W	γ Geminorum	6. 30. 19·60	20·77	29·73	8·96
			Sirius................	6. 39. 30·63	29·78	38·73	8·95
			ε Canis Majoris........	6. 53. 35·94	34·26	43·35	9·09
			λ Ursæ Minoris S.P. on wire *d*	7. 45. 58·	48. 22·77	31·77	9·00
			Moon II.............	8. 2. 8·63	10·72	——	+ [9·13]

November 23. The clock was stopped at 2h. 30m, Sidereal, to lengthen the pendulum. The seconds for ☽ II. at each wire are 47s·8, 0s·5, 13s·9, 27s·6, 41s·2. Sum of instrumental corrections, + 1s·76; correction applied for ☽'s motion in R.A., + 0s·08.

November 24. η Piscium and ι Aurigæ, the illumination nearly failed. The seconds for ☽ II. at each wire are 43s·1, 56s·6, 10s·1, 24s·1, 37s·7. Sum of instrumental corrections, + 1s·86; correction for ☽'s motion in R.A., + 0s·09. The clock was stopped at 1h. 50m, Sidereal, to lengthen the pendulum.

November 26. ☽ II. 42s·1, 55s·3, 8s·5, 22s·1, 35s·8. Sum of instrumental corrections, + 2s·00. Correction for ☽'s motion in R.A., + 0s·09. The level was adjusted before the observations. The Azimuth was partially adjusted on λ Ursæ Minoris S.P. with wire *d*. The sky then clouded over.

Day.	Position of the Illuminating Lamp.	Object observed and (Number of Wires).	Mean observed Clock Time of Transit over the Center Wire.	Seconds of True Transit over the Meridian.	Seconds of Star's Assumed Apparent R.A.	Clock apparently Slow.
1874.			h m s	m s	s	s
December 6	W	ε Tauri	4. 20. 48·18	49·85	19·68	+ 29·83
		Bradley 625 (4)	4. 25. 58·43	0·01	29·56	29·55
		Aldebaran (4)	4. 28. 14·68	16·26	45·54	29·28
		μ Eridani	4. 38. 45·01	46·16	15·89	29·71
	E	ι Aurigæ	4. 48. 22·20	22·66	51·95	29·29
		ε Leporis (2)	4. 59. 42·39	41·63	11·16	29·53
7	E	σ Ceti	2. 25. 39·98	39·74	10·41	30·65
		δ Ceti	2. 33. 34·45	34·41	5·02	30·61
		ζ Persei	3. 45. 46·32	46·55	17·18	30·63
		γ^1 Eridani	3. 51. 42·26	42·04	12·63	30·59
		o^1 Eridani	4. 5. 15·91	15·81	46·57	30·76
		γ Tauri	4. 12. 10·56	10·66	41·45	30·79
	W	Aldebaran	4. 28. 13·22	14·78	45·55	30·77
		μ Eridani	4. 38. 43·57	44·87	15·90	31·03
9	W	β Ceti	0. 36. 43·38	44·54	18·90	34·36
		δ Piscium	0. 41. 35·77	37·26	11·63	34·37
		μ Andromedæ	0. 49. 12·39	14·51	48·76	34·25
		ε Piscium	0. 55. 51·69	53·17	27·31	34·14
		Polaris (4)	1. 11. 30·32	12. 28·55	2·73	34·18
	E	Polaris (4)	1. 12. 27·23	28·90	2·73	33·83
		ν Piscium (2)	1. 34. 21·62	21·66	55·71	34·05
		β Arietis	1. 47. 10·00	10·20	44·24	34·04
		ξ^1 Ceti	2. 5. 48·95	49·04	22·80	33·76
		67 Ceti	2. 10. 11·71	11·62	45·30	33·68
		ξ^2 Ceti	2. 20. 57·45	57·52	31·13	33·61
		ν Ceti	2. 28. 45·33	45·37	19·22	33·85
		γ^2 Ceti	2. 36. 15·99	16·01	49·85	33·84
14	E	δ Piscium	0. 41. 27·01	26·99	11·59	44·60
		67 Ceti (4)	2. 10. 0·71	0·43	45·28	44·83
15	E	Moon I. (4)	23. 25. 0·93	0·51	——	[46·66]
		γ Tauri	4. 11. 54·52	54·63	41·50	46·87
		r Tauri	4. 16. 16·78	16·76	3·67	46·91
		Aldebaran (Obs. G. L. T.)	4. 27. 58·50	58·62	45·59	46·97
		55 Eridani	4. 36. 49·17	48·72	35·77	47·05
		i Tauri	4. 43. 17·00	17·03	4·51	47·48
	W	64 Eridani	4. 53. 19·86	20·74	8·12	47·38
		ε Leporis (Obs. G. L. T.)	4. 59. 22·82	23·49	11·23	47·74
		κ Leporis	5. 6. 40·18	41·03	28·50	47·47
		21 Orionis	5. 11. 51·83	53·04	40·80	47·76
		ψ^2 Orionis (Obs. G. L. T.)	5. 19. 29·28	30·50	18·20	47·70
		126 Tauri	5. 33. 15·68	17·26	4·16	+ 46·90

December 15. ☽ I. ——, $48^s·2$, $1^s·0$, $12^s·8$, $24^s·4$. A mistake of 1^s. has been assumed at the second wire. Sum of instrumental corrections, $-0^s·40$; correction for ☽'s motion in R.A., $-0^s·01$. Four stars observed by Captain Tupman.

Day.		Position of the Illuminating Lamp.	Object observed and (Number of Wires).	Mean observed Clock-Time of Transit over the Center Wire.	Seconds of True Transit over the Meridian.	Seconds of Star's Assumed Apparent R.A.	Clock apparently Slow.
1874.				h m s	m s	s	s
December	15	W	α Orionis (Obs. G. L. T.)	5. 47. 36·48	37·80	25·05	+ 47·25
			δ Ursæ Minoris S.P. (1)	6. 12. 5·64	11. 31·91	19·36	47·45
			24 Ursæ Minoris S.P. (3)	6. 16. 32·08	15. 54·00	41·57	47·57
	16	W	23 Sextantis	10. 13. 43·47	44·80	34·29	49·49
			25 Sextantis	10. 16. 16·41	17·62	7·37	49·75
			30 Sextantis	10. 23. 2·67	3·96	53·93	49·97
			49 Leonis	10. 27. 37·22	38·68	28·59	49·91
		E	b^3 Hydræ.............	10. 46. 33·50	32·99	22·33	49·34
			Bradley 3058 S.P.	10. 54. 26·61	23·11	12·68	49·57
			δ Leonis	11. 6. 37·26	37·55	27·36	49·81
			δ Crateris	11. 12. 15·98	15·61	5·07	49·46
			λ Crateris	11. 16. 20·68	20·20	9·69	49·49
	17	W	Polaris (3)	1. 10. 38·97	12. 8·72	56·25	47·53
		W	Moon I.	1. 7. 41·83	43·24	——	[51·08]
		E	Polaris (4)	1. 11. 32·33	12. 5·05	56·25	51·20
			α Ceti................	2. 54. 54·65	54·51	45·23	50·72
			53 Arietis	2. 59. 33·00	33·18	23·92	50·74
			δ Arietis	3. 3. 38·36	38·57	29·40	50·83
			ζ Arietis	3. 6. 52·54	52·80	43·51	50·71
			96 Ceti	3. 11. 58·13	57·96	48·89	50·93
		W	10 Tauri..............	3. 29. 37·91	39·12	30·32	51·20
			θ Ursæ Minoris S.P. ...	3. 34. 23·78	14·55	5·84	51·29
			31 Tauri	3. 44. 28·01	29·36	20·98	51·62
			33 Eridani (4)	3. 47. 32·79	33·35	24·64	51·29
			γ^1 Eridani	3. 51. 20·62	21·47	12·66	51·19
			ω^1 Tauri..............	4. 1. 0·88	2·60	53·74	51·14
	21	E	Polaris (4)	1. 14. 6·19	11. 52·45	51·77	59·32
		W	Polaris (3)	1. 13. 6·44	11. 49·44	51·77	62·33
			Groombridge 2053 S.P..	1. 40. 56·14	41. 7·48	8·08	60·70
			σ Ceti.................	2. 25. 7·12	10·62	10·34	59·72
			δ Eridani.............	3. 36. 13·32	16·50	16·35	59·85
		E	31 Tauri	3. 44. 20·85	21·91	20·98	59·07
			γ^1 Eridani	3. 51. 11·16	13·09	12·65	59·56
			40 Tauri	3. 56. 7·07	8·15	7·73	59·58
			Moon I................	5. 10. 16·97	17·01	——	[59·65]
			β Tauri	5. 17. 24·63	24·57	24·35	59·78
			118 Tauri	5. 20. 35·99	36·16	35·80	59·62
			B. A. C. 1746	5. 27. 6·27	6·25	5·84	59·59
	22	E	Bradley 1731 S.P......	0. 46. 42·53	47. 14·22	15·86	61·66
			Polaris...............	1. 13. 55·36	11. 45·44	51·05	65·61
		W	Polaris (4)	1. 13. 7·05	11. 52·92	51·05	+ 58·13

December 15. δ Ursæ Minoris S.P. on wire *b* at $6^h. 17^m. 3^s$.
December 17. ☽ I. $18^s·1$, $29^s·9$, $41^s·8$, $54^s·0$, $5^s·9$. Sum of instrumental corrections, $+1^s·36$; correction for ☽'s motion in R.A., $+0^s·05$.
December 21. ☽ I. $49^s·8$, $2^s·8$, $17^s·1$, $30^s·3$, $44^s·2$. Illumination bad. Sum of instrumental corrections, $+0^s·04$.

Day.		Position of the Illuminating Lamp.	Object observed and (Number of Wires).	Mean observed Clock-Time of Transit over the Center Wire.	Seconds of True Transit over the Meridian.	Seconds of Star's Assumed Apparent R.A.	Clock apparently Slow.
1874.				h m s	m s	s	s
December	22	W	70 Ceti	2. 14. 45·77	48·13	50·68	+ 62·55
			71 Ceti	2. 17. 34·69	37·21	39·76	62·55
			ξ² Ceti	2. 20. 26·85	28·87	31·08	62·21
			29 Arietis	2. 24. 59·80	1·57	3·66	62·09
		E	δ Ceti	2. 32. 2·19	3·17	4·96	61·79
			γ Ceti	2. 34. 46·97	47·82	49·70	61·88
			π Arietis	2. 41. 17·40	17·61	19·40	61·79
			Moon II. (4)	6. 21. 29·88	29·47	——	[62·20]
1875.							
January	2	W	Polaris (3)	1. 10. 40·53	(11. 48·05)	42·97	
		E	Polaris (4)	1. 12. 11·71	12. 23·00	42·97	19·97
			ν Piscium (2)	1. 34. 36·27	36·00	55·52	19·52
			ο Piscium	1. 38. 28·05	27·83	47·53	19·70
			Groombridge 2053 S.P..	1. 41. 50·29	49·36	9·42	20·06
			β Arietis	1. 47. 24·52	24·46	44·05	19·59
			ι Arietis	1. 50. 11·98	11·89	31·34	19·45
			57 Ceti	1. 53. 34·68	33·94	53·69	19·75
			α Piscium	1. 55. 15·61	15·30	34·90	19·60
			α Arietis	1. 59. 48·06	48·05	7·68	19·63
			62 Ceti	2. 2. 30·67	30·29	49·99	19·70
			63 Ceti (4)	2. 4. 55·36	54·99	15·25	20·26
		W	θ Arietis (4)	2. 10. 48·95	50·35	10·47	20·12
			69 Ceti	2. 15. 11·35	12·39	32·64	20·25
			ξ Arietis	2. 17. 45·92	47·13	7·24	20·11
			ξ² Ceti (3)	2. 21. 9·67	10·82	31·00	20·18
			ν Ceti	2. 28. 57·91	59·03	19·08	20·05
			δ Ceti	2. 32. 43·71	44·75	4·89	20·14
			γ² Ceti	2. 36. 28·45	29·54	49·74	20·20
	3	W	Polaris (4)	1. 11. 16·39	12. 21·28	40·60	19·32
		E	Polaris (4)	1. 12. 9·69	12. 17·98	40·60	22·62
			69 Ceti	2. 15. 12·01	11·68	32·59	20·91
			Lalande 4458 (3)	2. 17. 29·13	28·27	49·15	20·88
			σ Ceti (4)	2. 25. 49·74	49·15	10·23	21·08
			ν Ceti	2. 28. 58·71	58·45	19·05	20·60
			ν Arietis	2. 31. 22·74	22·68	43·37	20·69
		W	γ² Ceti	2. 36. 27·45	28·57	49·73	21·16
			π Arietis	2. 41. 56·96	58·31	19·32	21·01
			σ Arietis	2. 44. 13·52	14·83	35·77	20·94
			β Ursæ Minoris S.P. ...	2. 50. 47·42	42·20	4·23	22·03
			α Ceti	2. 55. 22·99	24·13	45·15	21·02
			δ Arietis	3. 4. 6·70	8·11	29·33	21·22
	4	E	o² Orionis (4)	4. 48. 58·06	58·66	21·46	22·80
			Lalande 9354 (2)	4. 51. 39·87	39·67	2·49	+ 22·82

December 22. ☽ II. ——, 16s·1, 30s·0, 43s·5, 56s·8. Sum of instrumental corrections, $-0^s \cdot 40$; correction for ☽'s motion in R.A., $-0^s \cdot 01$.
January 2. The act of reversal appears to have disturbed the azimuthal adjustment. Observer's eyes fatigued.
January 4. Observer's eyes fatigued. δ Ursæ Minoris S.P., Lamp E, on wire *k* at 6h. 18m. 33s.

Day.	Position of the Illuminating Lamp.	Object observed and (Number of Wires).	Mean observed Clock-Time of Transit over the Center Wire.	Seconds of True Transit over the Meridian.	Seconds of Star's Assumed Apparent R.A.	Clock apparently Slow.
1875.			h m s	m s	s	s
January 4	E	ε Ursæ Minoris S.P.	4. 58. 18·89	21·19	43·56	+ 22·37
		κ Leporis.............	5. 7. 5·88	5·69	28·58	22·89
		Piazzi IV. 317........	5. 9. 53·44	52·88	17·03	24·15
		m Orionis	5. 15. 53·35	53·30	16·71	23·41
		114 Tauri	5. 19. 45·21	45·33	8·64	23·31
		31 Orionis............	5. 23. 0·95	0·86	24·11	23·25
		δ Orionis	5. 25. 14·85	14·77	38·19	23·42
		Bradley 801	5. 28. 33·79	33·68	56·98	23·30
		126 Tauri	5. 33. 41·80	41·82	5·41	23·59
	W	κ Orionis.............	5. 41. 26·30	27·65	50·69	23·04
		χ^2 Orionis............	5. 47. 8·32	9·95	33·74	23·79
		60 Orionis (4)	5. 52. 0·01	1·43	24·95	23·52
		1 Geminorum	5. 56. 7·14	8·82	32·36	23·54
		ν Orionis.............	6. 0. 2·16	3·71	27·11	23·40
		η Geminorum	6. 6. 55·78	57·55	21·00	23·45
		δ Ursæ Minoris S.P. (3)	6. 12. 11·62	11. 53·21	18·51	25·30
	E	δ Ursæ Minoris S.P. (1)	6. 11. 55·88	0·33	18·51	+ 18·18

TABLE V.—ERRORS and RATE of the TRANSIT-CLOCK at KAILUA.

Day.	Sidereal Time.	Clock Slow.	Clock's Loss in 24^h.	Adopted Losing Rate.	Day.	Sidereal Time.	Clock Slow.	Clock's Loss in 24^h.	Adopted Losing Rate.
1874.	h m	s	s	s	1874.	h m	s	s	s
Nov. 23	23. 22	+18·28*	+16·0	+16·0	Dec. 13	1. 41	+ 42·30	+ 2·06	+ 2·33
	1. 55	+19·99*			14	1. 26	44·87*	2·60	2·33
					15	4. 50†	47·21	2·05	2·01
	4. 51	+18·37*	−15·63	−15·63	16	10. 44	49·66	1·96	1·90
24	1. 23	+ 4·96*			17	3. 26	51·04	1·87	1·91
					18	1. 21	52·81	1·94	2·01
	4. 14	+ 3·98*	+ 2·27	+ 2·27	21	3. 50	59·66	2·21	2·49
26	6. 41	8·75*		2·39	22	2. 29	62·09	2·58	2·48
28	0. 11	13·09*	2·51	2·28	28	2. 30	13·30	1·87	1·36
30	1. 8	17·26*	2·05	2·26	29	1. 34	14·52	1·27	1·23
Dec. 1	1. 16	19·64	2·37	2·08	31	3. 32	16·91	1·16	1·51
2	3. 18	21·58*	1·79	1·84	1875.				
3	3. 0	23·44	1·89	1·97	Jan. 1	3. 56	18·60*	1·68	1·65
4	1. 18	25·35	2·05	2·00	2	2. 9	19·92	1·63	1·33
6	4. 42	29·50	1·93	1·58	3	2. 36	20·95	1·02	1·57
7	4. 2	30·79	1·43	1·53	4	5. 35	23·33	2·12	2·12
9	1. 28	34·05	1·73	1·91	13	2. 51	45·93*	2·53	2·50
11	1. 17	+ 38·18	+ 2·08	+ 2·07	19	3. 54	+ 57·90*	+ 1·97	+ 2·00

* Instrument used in one position only.

† December 15, 4^h. 56^m, clock slow $+47^s{\cdot}26$. Observer, Captain Tupman.

TRANSIT OF VENUS, 1874.

PART I.

EXPEDITION TO THE HAWAIIAN ISLANDS

(*continued*).

Section 3.

OBSERVATIONS AT WAIMEA,

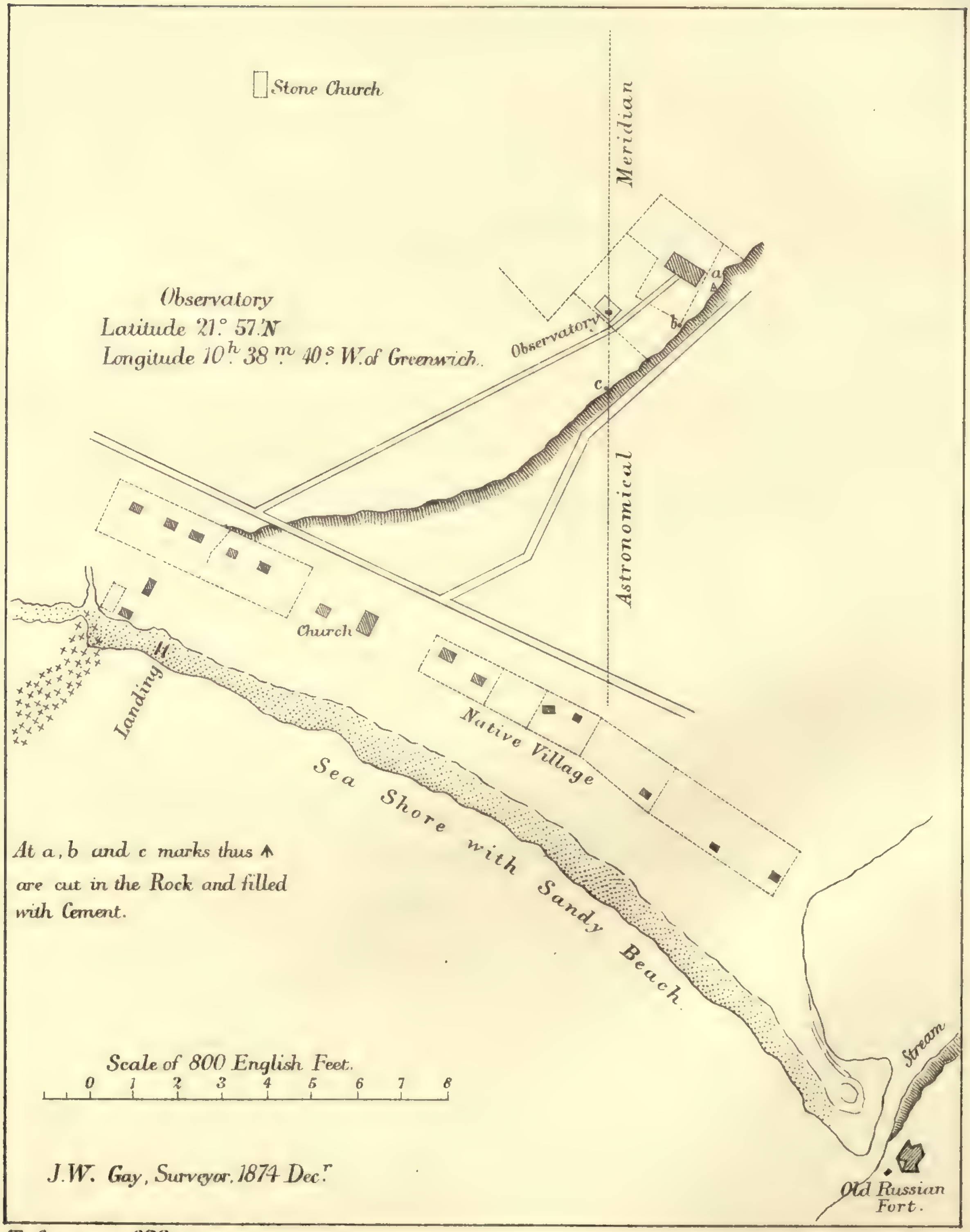
BY R. JOHNSON, ESQ.

H H

CONTENTS.

Transit of Venus, 1874 Dec. 8.

Plan of the Village of Waimea, on the Island of Kauai, showing the position of Mr Johnson's Observatory.



To face page 232.

DANGERFIELD, LITH. 22 BEDFORD ST COVENT GARDEN

OBSERVATIONS AT WAIMEA, ISLAND OF KAUAI (ATOOI).

BY RICHARD JOHNSON, ESQ.

Mr. Johnson, accompanied by Sub-Lieutenant R. H. Wellings, R.N., and some artificers, left Honolulu for Kauai, 1874, November 6. Receiving much friendly assistance from Mr. Kanutsen, the principal resident, he found at Waimea a suitable dwelling-house with convenient ground around it, a portion of which was fenced in for the observatories. The position with regard to surrounding objects was surveyed and plotted, as in the accompanying plan, by Mr. J. N. Gay, Surveyor, of Honolulu. It was about 80 feet above the sea, and half a mile inland from the landing-place. The exact site of the transit pier, in case of its removal, could be recovered from the following description:—Near the edge of the rocky cliff overhanging Valley Road, 35 feet E.S.E. from the S. corner of the dwelling-house, a mark ↑ has been chiselled in the rock and filled with cement. From this spot the bearings below were taken:—

	° ′
Lehau Island, highest peak - - -	N. 81. 12. W. (true)
Old Russian Fort at mouth of stream - -	S. 12. 50. E.
Sharp Peak in Kauai Range - - -	N. 57. 50. E.
Transit pier, distant 231 feet - - -	S. 78. 55. W.

Two similar marks were cut in the rock on the edge of the cliff to the S.W., distant 90 and 346 feet respectively from the above-mentioned mark, and distant 174 and 199 feet respectively from the transit pier.

Mr. Johnson was provided with a transit instrument and three chronometers for obtaining local time. The chronometers are those named J, L, and N in the list at page 31. The dial of N was divided to 24 hours; it was regulated to Sidereal time, and Mr. Johnson used it when observing. Chronometer J, with 12-hour dial, was also regulated to Sidereal time, while L was a mean-time chronometer. The three were kept on the transit pier and inter-compared (by coincidence of beats) twice a day (Table V.).

The transit instrument, which was kindly lent to the Astronomer Royal by REGINALD BUSHELL, Esq., of Hinderton, near Chester, was made by Messrs. Troughton and Simms. The object glass was $2\frac{1}{8}$ inches aperture and 31 inches focal length. The Y's were supported by short stone piers, which stood upon a stone slab forming the top of a substantial brick pier,

founded on a bed of hard red clay, six feet below the surface of the ground. It was protected by a small hut, which was almost entirely removed during observation.

The reticule consisted of five fixed wires of cobweb and one movable by a micrometer screw, besides the usual pair of horizontal wires to define the middle of the field. The value of a revolution of the micrometer screw was found from a great number of observations of *Polaris* to be 65″·52. The revolutions of the screw were numbered in the observing books with increasing readings towards the head. When the movable wire coincided with the center wire, the reading was—

r
10·043 on December 6,
10·045 on December 15,
10·046 on December 20.

The reading $10^r \cdot 043$ has been used throughout the reductions.

The Equatorial intervals of the wires were found by means of the movable wire and the known value of the micrometer screw as follows:—

	″
a	+ 399·94
b	+ 203·57
c	0·00
d	− 201·08
e	− 396·20

When the micrometer head was on the east side of the telescope, equatorial stars transited the wires in the order above.

The *Level Error* (Table I.) was found by means of a striding spirit-level. The original glass bubble of the level was accidentally broken at Honolulu, and it was replaced by a spare bubble intended for the Altazimuth. The value of the divisions was determined by attaching the glass bubble to the telescope of the Altazimuth.

1874. October 20,	21·25	divisions	were found	equivalent to	70″·30;	$1^{div.}$ =	3″·31
	11·10	„	„	„	37″·40;	„	3″·37
October 21,	18·45	„	„	„	62″·00;	„	3″·36
	16·70	„	„	„	58″·43;	„	3″·49
	16·00	„	„	„	55″·47;	„	3″·48
	24·25	„	„	„	77″·18;	„	3″·18
November 6,	19·80	„	„	„	66″·77;	„	3″·32

The mean value 3″·36 was adopted. Mr. Johnson had considerable trouble with this striding level, as it was continually requiring to be adjusted. For this reason the level was not applied quite as often as was desirable. It was Mr. Johnson's habit to apply the level, in both positions of the transit instrument, on the finish of his night's work. Although the piers were of stone, the illuminating lamp seems to have disturbed the level error. The "clock slow" obtained from stars with lamp E. is generally greater than with lamp W. Mr. Johnson always observed clock stars with both positions of the instrument.

The correction to the level error for inequality of the pivots was found by repeated levellings to be −0″·42 (micrometer E.).

The *Error of Collimation* of the fixed center wire of the transit was obtained from observations of close circumpolar stars with reversed positions of the transit axis. All such observations were transits over the movable wire, and the error of collimation of the center fixed wire is obtained from them by assuming that it coincided with the movable wire when the micrometer reading was $10^{r}\cdot043$. The individual determinations are given in Table II.

The *Error of Azimuth* was obtained in the usual manner from the observations of close circumpolar stars combined with those of clock stars. The errors are given in Table III. There is no mention made of the adjustments having been altered between the observations of December 3 and December 4.

TRANSITS OF STARS observed at WAIMEA (Table IV.).

The places of the stars Bradley 95, 402, 3147, 3187, Groombridge 642, 750, and Lalande (Fed.) 693 have been brought up from the Greenwich new 7-year and 9-year Catalogues for 1864 and 1872. The constants for computing the apparent places were extrapolated for 1875·0 from those contained in the annual volumes of the *Greenwich Observations.*

For complete transits, the mean observed time of transit by chronometer N over the five wires was reduced to the center wire by applying the correction $\frac{1^{s}\cdot 25}{15 \text{ Sin. N.P.D.}}$ additive when the micrometer-head was east. For imperfect transits, each wire was reduced to the center wire by means of the intervals given on page 238. When only one side wire has been observed, the time recorded is given at the foot of the page. The *level error* proper for the position of the transit axis, as given in Table I., has been used, taking the mean where it has been observed more than once. The value of the *Colli-*

mation Error used throughout is $3''\cdot 65$, positive with micrometer west. There are a few days when, strictly speaking, a smaller value ought to have been employed, but the fact has no importance, as Mr. Johnson was careful to observe time-stars with both positions of the instrument. The observations of close circumpolar stars were made with the micrometer wire; the wire was moved successively by quantities equal to one-half or one-quarter of a revolution of the screw, and the star then allowed to transit. With *Polaris* it was Mr. Johnson's habit to record the time when the star's disk seemed to be just touching the wire on both sides. The successive intervals, corresponding to the instants of bisection of the star's disk thus obtained, are not so accordant as those obtained by other observers by the method of estimating the instant of bisection. The number of observations of the circumpolar star, counting the two contacts as one, is shown by a number following the mean micrometer reading thus "Polaris $8^{r}\cdot 750$ (8)." The observations with the two positions of the transit axis have been separately reduced. On the days referred to above, when a different collimation error should have been employed, they, of course, appear discordant.

The star's apparent R.A. includes the effect of diurnal aberration.

The transits selected for publication are those on which depend the difference of Longitude with Honolulu and the Local Time for the Transit of Venus.

APPROXIMATE LATITUDE of WAIMEA.

The approximate latitude depends upon the meridian altitudes of the Sun's upper limb, as observed, on 22 days in November and December 1874, by Lieutenant Wellings, with an ordinary navigator's sextant by Whitbread, and mercurial horizon. The Index error of the sextant was determined in the usual way by observing the diameter of the Sun "on" and "off" the arc. The mean instrumental diameter of the Sun was 4″ greater than the tabular diameter. No mention is made of the other errors of the sextant, or of the dark glasses employed. The mean of Lieutenant Wellings' observations gives the latitude—

$$21^{\circ}.\ 57'\cdot 2 \text{ N.},$$

which is probably within one minute of the truth.

LONGITUDE of WAIMEA.

The determination of the difference of longitude between Mr. Johnson's station and that at Apua, Honolulu, has been described in detail in the

preceding pages. The transit instrument at Waimea was found to be $7^{m}.\ 13^{s}{\cdot}48$ West of the transit instrument at Honolulu. Assuming the longitude of Honolulu to be $10^{h}.\ 31^{m}.\ 26^{s}{\cdot}3 \pm 2^{s}$, the longitude of Waimea is $10^{h}.\ 38^{m}.\ 39^{s}{\cdot}8 \pm 2^{s}$ West of Greenwich.

REPORT of MR. R. JOHNSON on his OBSERVATION of the INGRESS of VENUS, 1874, December 8.

On 1874, December 7, H.M.S. *Reindeer* arrived and anchored to the east of Waimea river. Arrangements were made with Captain ANSON, her Commander, for the protection of the observatory ground against intrusion on December 8, and that Nav. Sub-Lieut. WARLEIGH should assist the Rev. Mr. Dunn during the transit.

A tent was pitched outside the observatory inclosure to cover Mr. Dunn's telescope, so that any confusion arising from our respective orders might be avoided.

On December 8, everything being in good order and the chronometers compared, the sentries were posted in due time and in proper places. This precaution, however, was scarcely necessary, as I had the grounds "tabooed," or, as they call it, "kapu," for the day.

Mr. Wellings and I took up our posts about 15 minutes before the time of expected external contact.

Twelve minutes before internal contact the entire disk of Venus was distinctly visible, a faint ring of light beginning to appear round the edge off the Sun. Four minutes and a half later the ring of light was very plain. No *black* drop like that which we see in the *model* appeared at all.

The cusps had not the sharpness they often have in the model on a good day. The weather was beautiful, not the faintest cloud or mist appeared.

Time by Sidereal Chronometer N.	
h m s	
At 20. 35. 0·	whole disk of Venus completely visible.
20. 39. 30·	ring of light complete.
20. 44. 55·	ring of light.
20. 46. 34·	notice to Lieut. Wellings to attend carefully.
20. 46. 53·0	$\left\{\begin{array}{c}\text{cusps}\\ \text{indefinite light}\end{array}\right\}$ beginning to appear to meet.
20. 47. 2·3	meeting of cusps appeared to take place, and light clearing.

Time by Sidereal Chronometer N.	
h m s	
At 20. 47. 7·2	a distinct band of light between edge of Venus and Sun's limb.
20. 47. 15·4	Venus well on the Sun's disk.

No *black* drop appeared. When internal contact was very near, the brownish smoke-like colour between the edge of Venus and the Sun began to clear off.

At $20^h. 35^m. 0^s$ the entire disk of Venus was perfectly visible, the part outside the Sun having a faint ring of light round it, except at the western edge. The light was visible round it about two-thirds of the extent of Venus outside the Sun. At $20^h. 39^m. 30^s$. the ring of light was complete.

I am inclined to think the actual contact took place between $20^h. 46^m. 53^s\cdot0$ and $20^h. 47^m. 2^s\cdot3$, the light appearing to break through at the first time, and certainly at the last.

At $20^h. 46^m. 53^s\cdot0$ light flashed for an instant between the edge of Venus and the Sun's limb, but immediately disappeared. It was as if the cusps met in a flash.

At $20^h. 47^m. 2^s\cdot3$ the cusps most certainly met, and after that the light between the edge of Venus and the Sun's limb continued to widen until $20^h. 47^m. 7^s\cdot2$, when the band of light between the edge of Venus and the Sun's limb was very distinct. The reason I am inclined to put the contact a little before $20^h. 47^m. 2^s\cdot3$ is in consequence of the flash of light before mentioned, and the short time which elapsed before Venus was well on the Sun.

Ordinarily in the *model* one sees a *dark* (black) band between Venus and the Sun's limb just before contact, and the light breaks through this band. In the actual transit, as I observed it, no *black* band appeared, but in place of that a smoke-coloured darkness, through which it was much more difficult to discern the breaking through of light, or in other words the meeting of the cusps.

About $7^m. 32^s\cdot3$ before the actual contact, the light of the Sun crept round the outside edge of Venus, which, though very faint, was distinctly visible. Mr. Wellings observed it as well as myself, as I called his attention to it so that there should be no mistake about it. This light continued till very near contact, when it became excessively faint, and the smoke-like appearance I have measured took its place.

All the times recorded refer to the *internal* contact at Ingress. I observed the external contact, but not, I think, with sufficient accuracy to allow me to record it. Moreover, I did not like to take the time of external contact, lest I should be biassed by the calculated interval between the external and internal contacts.

There was scarcely any appreciable "boiling" of the Sun's limb.

The observing telescope was mounted on a solid wooden post within the inclosure, but sufficiently far from the fence to prevent the heated air streaming from the top of the fence producing, by its changeable refraction, any unsteadiness in the view. The power used was a Hughenian eye-piece of 130.

R. JOHNSON.

The telescope used by Mr. Johnson was an achromatic by Dollond of $3\frac{1}{2}$ inches aperture and 46 inches focal length, of excellent definition. It was fitted by Messrs. Troughton and Simms with a solar diagonal reflector. Dark glasses screwed on at the eye-end. It had a steady but simple kind of equatorial mounting, attached to the top of a heavy baulk of timber sunk several feet in the ground, and was used in the open air. There was a slow-motion screw in Right Ascension with a convenient handle.

Mr. R. Dunn's Observation.

The Reverend Robert Dunn, of Honolulu, having expressed his intention of visiting Waimea about the epoch of the Transit of Venus, there was placed at his service an achromatic by Dollond, belonging to the Royal Observatory, Greenwich, of 2·7 inches aperture and 33 inches focal length, fitted with a solar diagonal reflector, negative eye-pieces of powers 67 and 134, and a neutral tint achromatised wedge. The telescope was mounted upon a firm tripod stand, with altazimuth movements and steadying rods of the usual construction; but, in consequence of the shortness of the tube between the eye-end and the principal point of support, and the absence of mechanism for giving slow motion, it was difficult to follow the diurnal motion, especially with the higher power.

Mr. Dunn practised for several days with the model at Honolulu. Such observations could be made with this small instrument quite as accurately as with the larger ones, with the power 134, but not with the lower power.

At Waimea, Mr. Dunn's station was 60 yards N.E. of Mr. Johnson's. The time of his observation was recorded, from the Solar chronometer L, by Sub-Lieut. Warleigh, of H.M.S. *Reindeer*. He made use of the power 67.

Mr. Dunn writes:—

"Before internal contact, $\frac{1}{4}$ or $\frac{1}{5}$ of the planet being still off the Sun's disk, I saw light all round the planet. My impression was that I was deceiving myself, through wishing to see the whole disk, but I failed in endeavouring *not* to see this ring of light. When I say $\frac{1}{4}$ or $\frac{1}{5}$ of the planet not being yet on the Sun's disk, I mean some considerable interval before the internal contact. I have not experience enough to judge such things, and I did not mark the time. As the moment of contact approached, a sort of misty, smoky, or woolly cloud seemed to be where we looked for the black drop. The time recorded [$3^h. 39^m. 1\frac{1}{4}^s$] was when I was sure of sharp clear light between the planet and the outer limb of the Sun. The instrument was unsteady through the wind, blowing sharply from S.W., just about the time of contact, and my own impression was that I was decidedly late.

"Having to leave Waimea an hour after the contact was observed, Mr. Johnson undertook the comparison of chronometers, &c.

"1874, December 10. R. DUNN."

For Mr. Johnson's observation of internal contact we have—

	h m s		h m s
Recorded times by the Sidereal chronometer N	20. 46. 53·0 20. 47. 2·3	Mean	20. 46. 57·65
Adopted Correction of N (Table VI.)			−7. 36·47
Local Sidereal Time			20. 39. 21·18
Assumed Longitude West			10. 38. 39·80
Greenwich Sidereal Time			7. 18. 0·98
Local Tabular Distance of Centers			15′. 37″·56

Whence the following final equation, assuming, as before—

$$R = 976''\cdot80, \qquad r = 31''\cdot42,$$

$$7''\cdot82 = -0''\cdot2280\, n + \cdot6535\, \delta\, \text{R.A.} - \cdot7058\, \delta\, \text{N.P.D.} - 0''\cdot0340\, \delta\, t - \delta\, R + \delta\, r.$$

For Mr. Dunn's observation we have—

	h m s
Recorded time by Solar chronometer L	3. 39. 1·25
Correction of L (Table VIII.)	−9. 58·47
Local Mean Solar Time	3. 29. 2·78
Local Sidereal Time	20. 39. 39·69

G. L. T.

TABLE I.—LEVEL ERROR of the TRANSIT INSTRUMENT.

[The sign − indicates that the East Pivot is high.]

Day.	Sidereal Time of Level Determination.	Micrometer E or W.	Level Error corrected for Inequality of Pivots.
	h m		″
1874. December 2	3. 50	E	− 4·18
	3. 55	W	− 5·54
	13. 10	E	− 3·04
3	3. 40	E	− 3·78
	3. 45	W	− 4·62
	3. 50	E	− 2·27
4	4. 40	E	− 3·44
	4. 42	W	− 5·12
	4. 48	W	− 3·85
	4. 50	E	− 3·28
	14. 40	E	− 2·10
5	4. 25	W	− 3·61
	4. 30	E	− 1·93
	4. 35	E	− 3·34
	4. 40	W	− 4·78
6	2. 10	W	− 4·71
	2. 15	E	− 4·04
	2. 20	W	− 3·95
	2. 25	E	− 3·11
7	2. 25	W	− 4·11
	2. 30	E	− 2·77
	2. 35	E	− 3·70
	2. 40	W	− 5·29
	6. 35	E	− 3·53
8	2. 40	E	− 3·51
	2. 45	W	− 5·46
9	3. 40	E	− 3·70
	3. 45	W	− 4·02
10	2. 10	W	− 3·61
	2. 15	E	− 2·84
11	2. 20	W	− 3·85
	2. 25	E	− 2·10
1874. December 12	6. 35	W	− 3·61
	6. 40	E	− 2·94
14	3. 15	W	− 3·44
	3. 20	E	− 2·94
15	23. 40	E	− 2·01
	3. 15	E	− 3·61
	3. 25	W	− 2·37
16	3. 50	E	− 2·18
	3. 55	W	− 3·10
17	1. 20	E	− 3·44
18	3. 15	W	− 2·43
	3. 20	E	− 1·76
19	3. 25	E	− 1·43
	3. 30	W	− 3·11
21	2. 50	E	− 2·27
	2. 55	W	− 2·77
22	2. 20	E	− 2·10
	2. 25	W	− 3·61
24	3. 0	W	− 3·27
	3. 5	E	− 2·52
1875. January 2	4. 5	E	− 0·42
	4. 10	W	− 1·76
4	2. 20	W	− 1·26
	2. 25	E	+ 1·40
5	6. 50	W	− 0·17
	6. 55	E	+ 0·25
10	6. 10	E	+ 0·02
	6. 20	W	− 0·59
12	7. 25	E	+ 0·93
	7. 30	W	+ 2·43

TABLE II.—ERROR OF COLLIMATION of the TRANSIT INSTRUMENT.

[The sign is considered Positive when it implies an additive correction to the time of observed transits of Stars above the Pole with the Micrometer West.]

Day.	Object.	Error of Collimation of Center Wire.	Day.	Object.	Error of Collimation of Center Wire.
1874.		″	1874.		″
December 2	Bradley 3147	+ 2·8	December 13	Polaris	+ 3·1
	Bradley 95	2·5	14	,,	3·5
	Polaris	3·4		A distant mark	3·7
3	Bradley 95	4·5	15	Polaris	4·5
	Polaris	2·4	16	,,	4·0
	Groombridge 642	3·0	18	,,	4·8
4	Polaris	3·0	19	,,	3·3
5	,,	2·5	20	A distant mark	3·4
6	,,	3·1	21	Polaris	3·7
7	,,	4·8	22	,,	1·8
	Lalande (Fed.) 693	4·0	24	,,	1·7
	δ Ursæ Minoris S.P.	4·0		Cephei (Hev.) 51	2·1
8	Bradley 402	5·7			
	δ Ursæ Minoris S.P.	3·7	1875.		
9	Polaris	5·0	January 2	Polaris	1·9
10	,,	4·5	4	,,	3·4
11	,,	3·5	5	δ Ursæ Minoris S.P.	3·7
12	Groombridge 750	4·6	10	λ Ursæ Minoris S.P.	1·9
	δ Ursæ Minoris S.P.	+ 4·3	12	δ Ursæ Minoris S.P.	+ 1·7

TABLE III.—AZIMUTH ERROR of the TRANSIT INSTRUMENT.

[The sign + denotes that the East Pivot was too far North.]

Day.	Stars.	Apparent Error of Azimuth.	Adopted Error of Azimuth.	Day.	Stars.	Apparent Error of Azimuth.	Adopted Error of Azimuth.
1874.		″	″	1874.		″	″
Dec. 2	Bradley 3147 and κ Piscium	−8·7		Dec. 7	Polaris and ε Piscium	+1·6	
	Bradley 95 and α Eridani	−9·1	−9·4		Lalande (Fed.) 693 and ξ¹ Ceti	+1·9	+1·6
	Polaris and ο Piscium	−9·9			δ Ursæ Min. S.P. and 1 Gem.	+1·0	
3	Bradley 95 and 20 Ceti	−8·7		8	Bradley 402 and α Eridani	+1·8	+2·7
	Polaris and η Piscium	−7·9	−8·1		δ Ursæ Min. S.P. and 1 Gem.	+1·1	
	Groomb. 642 and α Eridani	−7·4		9	Polaris and α Eridani	+5·2	+5·2
4	Polaris and β Ceti	+1·3	+1·3	10	,, ,,	+3·9	+3·9
5	Polaris and α Eridani	+2·4	+2·4	11	,, ,,	+4·5	+4·7
6	,, ,,	+2·2	+2·3	12	Groombridge 750 and α Tauri	+4·6	+4·3

Table III.—Azimuth Error of the Transit Instrument—*continued.*

Day.	Stars.	Apparent Error of Azimuth.	Adopted Error of Azimuth.	Day.	Stars.	Apparent Error of Azimuth.	Adopted Error of Azimuth.
1874.		″	″	1874.		″	″
Dec. 12	δ Ursæ Min. S.P. and ι Gem.	+4·1	+4·3	Dec. 22	Polaris and α Eridani	+6·9	+6·9
13	Polaris and α Eridani	+3·2	+3·2	24	,, ,, ...	+6·8	} +5·0
14	,, ,, ...	+8·2	+8·2		Cephei (Hev.) 51 and ε Canis	+4·1	
15	,, ,, ...	+4·6	+4·4	1875.			
16	,, ,, ...	+4·8	+4·8	Jan. 2	Polaris and α Eridani	+9·3	+9·4
17	,, ,, ...	+7·5	+7·5	4	,, ,, ...	+9·8	+9·8
18	,, ,, ...	+7·3	+7·3	5	δ Ursæ Min. S.P. and ν Orionis	+5·2	+5·0
19	,, ,, ...	+7·1	+7·1	10	λ Ursæ Min. S.P. and α Orionis	+3·9	+3·9
21	,, ,, ...	+7·4	+7·1	12	δ Ursæ Min. S.P. and γ Gem.	+8·4	+8·3

TABLE IV.—TRANSITS of STARS observed at WAIMEA by MR. R. JOHNSON.

Day.	Micrometer E or W.	Object observed and (Number of Wires).	Mean observed Time by Chronometer N of Transit over the Center Wire.	Seconds of True Transit over the Meridian.	Seconds of Star's Assumed Apparent R.A.	Chronometer N apparently Slow.
1874.			h m s	s	s	m s
December 7	E	γ Pegasi	0. 14. 26·43	25·97	47·57	− 7. 38·40
		44 Piscium	0. 26. 38·06	37·66	59·44	7. 38·22
		12 Ceti....................	0. 36. 18·14	17·76	39·35	7. 38·41
		ε Andromedæ	0. 39. 35·25	34·72	56·81	7. 37·91
		α Cassiopeiæ (4)	0. 41. 3·68	2·73	24·84	7. 37·89
		β Ceti	0. 44. 57·37	57·02	18·92	7. 38·10
		δ Piscium	0. 49. 50·24	49·81	11·65	7. 38·16
		20 Ceti	0. 54. 15·62	15·22	37·05	7. 38·17
		μ Andromedæ...............	0. 57. 27·39	26·78	48·78	7. 38·00
		ε Piscium	1. 4. 15·70	15·27	27·33	7. 37·94
		Polaris, 9·250 (5)	1. 18. 38·10	46·91	} 3·98	7. 39·70
	W	,, 9·250 (5)	1. 23. 6·20	40·46		
		α Eridani...................	1. 40. 42·36	42·91	5·19	7. 37·72
		ο Piscium	1. 46. 25·42	25·38	47·73	7. 37·65
		β Arietis	1. 55. 21·93	21·86	44·25	7. 37·61
		α Arietis	2. 7. 45·67	45·59	7·87	7. 37·72
		ξ[1] Ceti	2. 14. 0·48	0·44	22·81	7. 37·63
		67 Ceti	2. 18. 22·90	22·91	45·31	7. 37·60
	E	Lal. (F.) 693, 7·600 (5)......	4. 53. 13·90	33·44	} 55·43	7. 37·72
	W	,, 7·600 (5)	4. 57. 58·10	32·86		
		β Tauri	5. 26. 1·43	1·35	24·16	7. 37·19
		δ Orionis	5. 33. 14·98	14·97	37·96	7. 37·01
		ι Geminorum	6. 4. 9·53	9·45	31·98	− 7. 37·47

Table IV.—Transits of Stars—*continued.*

Day.	Micrometer E or W.	Object observed and (Number of Wires).	Mean observed Time by Chronometer N of Transit over the Center Wire.	Seconds of True Transit over the Meridian.	Seconds of Star's Assumed Apparent R.A.	Chronometer N apparently Slow.
1874.			h m s	s	s	m s
December 7	E	δ Ursæ Min. S.P., 14·000 (5) .	6. 14. 59·40	58·37	20·77	− 7. 38·01
	W	,, 14·000 (5) .	6. 24. 52·00	59·19		
		Canopus (4)................	6. 29. 49·01	49·43	12·33	7. 37·10
8	E	η Piscium	1. 32. 24·29	23·82	47·75	7. 36·07
		α Eridani....................	1. 40. 41·40	41·19	5·16	7. 36·03
		ο Piscium	1. 46. 24·30	23·86	47·72	7. 36·14
		β Arietis	1. 55. 20·81	20·31	44·24	7. 36·07
		α Arietis	2. 7. 44·35	43·84	7·87	7. 35·97
		ξ¹ Ceti	2. 13. 59·04	58·61	22·80	7. 35·81
		67 Ceti.....................	2. 18. 21·68	21·32	45·31	7. 36·01
		ξ² Ceti	2. 29. 7·54	7·11	31·14	7. 35·97
		ν Ceti......................	2. 36. 55·62	55·19	19·22	7. 35·97
		Bradley 402, 8·000 (5).......	3. 9. 19·50	46·77	9·94	7. 35·40
	W	,, 8·000 (5).......	3. 12. 17·30	43·91		
		1 Geminorum...............	6. 4. 7·97	7·83	32·00	7. 35·83
		ν Orionis	6. 8. 2·71	2·60	26·76	7. 35. 84
	E	δ Ursæ Min. S.P., 12·000 (5) .	6. 17. 25·30	57·93	20·53	7. 37·47
	W	,, 12·000 (5) .	6. 22. 21·80	58·07		
9	E	Polaris, 9·250 (5)	1. 18. 41·10	40·00	2·73	7. 33·50
	W	,, 9·250 (5)	1. 23. 6·80	32·50		
		α Eridani....................	1. 40. 37·54	38·54	5·13	7. 33·41
		67 Ceti	2. 18. 18·68	18·85	45·30	7. 33·55
		ξ² Ceti	2. 29. 4·52	4·58	31·13	7. 33·45
		δ Ceti......................	2. 40. 38·42	38·54	5·01	7. 33·53
		γ² Ceti	2. 44. 23·16	23·26	49·85	7. 33·41
		σ Arietis	2. 52. 9·29	9·30	—	—
	E	ε Arietis	2. 59. 38·53	38·02	4·38	7. 33·64
		α Ceti......................	3. 3. 19·42	19·05	45·22	7. 33·83
		τ Arietis	3. 21. 35·43	34·92	1·16	7. 33·76
		ο Tauri	3. 25. 40·00	39·59	5·80	7. 33·79
		f Tauri	3. 21. 33·13	32·69	58·89	7. 33·80
		ε Eridani	3. 34. 37·25	36·98	3·19	7. 33·79
10	E	44 Piscium	0. 26. 31·82	31·49	59·41	7. 32·08
		12 Ceti.....................	0. 31. 11·84	11·55	39·32	7. 32·23
		ε Andromedæ	0. 40. 29·23	28·70	56·77	7. 31·93
		β Ceti	0. 44. 51·19	50·96	18·90	7. 32·06
		δ Piscium	0. 49. 44·04	43·69	11·62	7. 32·07
		20 Ceti	0. 54. 9·56	9·26	37·02	7. 32·24
		μ Andromedæ...............	0. 57. 21·27	20·64	48·74	7. 31·90
		ε Piscium	1. 3. 59·84	59·49	27·31	− 7. 32·18

Table IV.—Transits of Stars—*continued.*

Day.		Micrometer E or W.	Object observed and (Number of Wires).	Mean observed Time by Chronometer N of Transit over the Center Wire.	Seconds of True Transit over the Meridian.	Seconds of Star's Assumed Apparent R.A.	Chronometer N apparently Slow.
1874.				h m s	s	s	m s
December	10	E	Polaris, 9·250 (5)	1. 18. 32·80	35·85	1·98	− 7. 31·67
		W	,, 9·250 (5)	1. 23. 1·90	31·25		
			α Eridani	1. 40. 35·82	36·68	5·11	7. 31·57
			ο Piscium	1. 46. 19·14	19·21	47·71	7. 31·50
			β Arietis	1. 55. 15·67	15·66	44·23	7. 31·43
			α Arietis	2. 8. 39·37	39·37	7·86	7. 31·51
	15	E	ε Piscium	1. 3. 47·10	46·76	27·27	7. 19·49
			Polaris, 8·625 (8)	1. 16. 21·63	19·11	57·82	7. 18·79
			,, 8·500 (8)	1. 25. 3·61	14·10		
		W	α Eridani	1. 40. 23·06	24·01	4·96	7. 19·05
			ο Piscium	1. 46. 6·69	6·86	47·68	7. 19·18
			β Arietis	1. 55. 3·37	3·46	44·18	7. 19·28
			α Arietis	2. 7. 26·91	26·98	7·83	7. 19·15
		E	γ^2 Ceti	2. 44. 9·56	9·24	49·84	7. 19·40
			σ Arietis	2. 51. 55·73	55·33	35·87	7. 19·46
			ε Arietis	2. 59. 24·15	23·70	4·37	7. 19·33
			α Ceti	3. 3. 4·86	4·53	45·23	7. 19·30
			δ Arietis	3. 10. 49·11	48·67	29·40	7. 19·27
			τ^1 Arietis	3. 21. 20·01	20·10	1·17	7. 18·93
	16	E	ε Piscium	1. 3. 44·72	44·39	27·26	7. 17·13
			Polaris, 8·875 (8)	1. 17. 3·25	14·38	55·95	7. 17·46
		W	,, 8·750 (8)	1. 24. 17·28	12·43		
			α Eridani	1. 40. 20·68	21·66	4·94	7. 16·72
			δ Arietis	3. 11. 46·13	46·19	29·40	7. 16·79
			τ^1 Arietis	3. 21. 17·83	17·88	1·17	7. 16·71
			ο Tauri	3. 25. 22·35	22·47	5·81	7. 16·66
			f Tauri	3. 31. 15·55	15·65	58·91	7. 16·74
			ε Eridani	3. 34. 19·71	19·95	3·19	7. 16·76
		E	δ Eridani	3. 44. 33·49	33·29	16·36	7. 16·93
			η Tauri	3. 47. 21·17	20·73	3·91	7. 16·82
	17	E	Polaris, 11·750 (1)	1. 26. 0·50	10·91	56·25	7. 14·66
			α Eridani	1. 40. 19·16	19·55	4·91	7. 14·64
	18	E	Polaris, 9·000 (7)	1. 17. 27·93	9·90	55·52	7. 10·75
		W	,, 8·875 (8)	1. 23. 50·94	3·50		
			α Eridani	1. 40. 14·25	15·52	4·89	7. 10·63
			ο Piscium	1. 45. 58·32	58·50	47·66	− 7. 10·84

Table IV.—Transits of Stars—*continued.*

Day.		Micrometer E or W.	Object observed and (Number of Wires).	Mean observed Time by Chronometer N of Transit over the Center Wire.	Seconds of True Transit over the Meridian.	Seconds of Star's Assumed Apparent R.A.	Chronometer N apparently Slow.
1874.				h m s	s	s	m s
December	18	W	β Arietis	1. 54. 54·85	54·95	44·18	− 7. 10·77
			δ Arietis	3. 11. 39·79	39·89	29·40	7. 10·49
		E	δ Eridani	3. 44. 27·30	27·20	16·36	7. 10·84
			η Tauri	3. 47. 15·09	14·68	3·91	7. 10·77
			γ^1 Eridani	3. 59. 23·73	23·66	12·66	7. 11·00
			37 Tauri	4. 5. 30·29	29·90	19·01	7. 10·89
	19	E	μ Andromedæ	0. 56. 58·28	57·72	48·63	7. 9·09
			ε Piscium	1. 3. 36·36	36·13	27·23	7. 8·90
			Polaris, 8·875 (8)	1. 16. 55·69	1·75	53·57	7. 9·05
		W	,, 8·750 (8)	1. 24. 14·28	3·50		
			α Eridani	1. 40. 11·95	13·20	4·85	7. 8·35
			ξ^2 Ceti	2. 28. 39·48	39·63	31·09	7. 8·54
			ν Ceti	2. 36. 27·38	27·55	19·18	7. 8·37
			δ Ceti	2. 40. 13·32	13·54	4·98	7. 8·56
			γ^2 Ceti	2. 43. 58·24	58·43	49·82	7. 8·61
			σ Arietis	2. 51. 44·15	44·25	35·86	7. 8·39
		E	ε Arietis	2. 59. 13·39	13·04	4·37	7. 8·67
			α Ceti	3. 2. 53·92	53·73	45·22	7. 8·51
			δ Arietis	3. 11. 38·27	37·92	29·40	7. 8·52
			τ^1 Arietis	3. 21. 9·97	9·61	1·16	7. 8·45
	21	E	μ Andromedæ	0. 56. 54·48	53·85	48·60	7. 5·25
			ε Piscium	1. 3. 32·54	32·26	27·21	7. 5·05
			Polaris, 9·125 (6)	1. 17. 38·25	55·87	51·80	7. 4·02
		W	,, 9·000 (7)	1. 23. 20·14	55·76		
			α Eridani	1. 40. 8·21	9·48	4·80	7. 4·68
			ν Ceti	2. 36. 23·72	23·93	19·17	7. 4·76
			δ Ceti	2. 40. 9·40	9·64	4·98	7. 4·66
			γ^2 Ceti	2. 43. 54·34	54·56	49·81	7. 4·75
		E	δ Arietis	3. 11. 34·57	34·16	29·39	7. 4·77
			τ^1 Arietis	3. 21. 6·29	5·87	1·16	7. 4·71
			ο Tauri	3. 25. 10·88	10·58	5·80	7. 4·78
			f Tauri	3. 31. 4·05	3·70	58·90	7. 4·80
			ε Eridani	3. 34. 8·04	7·90	3·17	7. 4·73
			δ Eridani	3. 44. 21·26	21·13	16·35	7. 4·78
			η Tauri	3. 47. 9·15	8·70	3·91	7. 4·79
			α Aurigæ	5. 14. 34·08	33·25	28·50	7. 4·75

Table IV.—Transits of Stars—*continued.*

Day.		Micrometer E or W.	Object observed and (Number of Wires).	Mean observed Time by Chronometer N of Transit over the Center Wire.	Seconds of True Transit over the Meridian.	Seconds of Star's Assumed Apparent R.A.	Chronometer N apparently Slow.
				h m s	s	s	m s
1874. December	22	E	ε Piscium	1. 3. 31·02	30·76	27·20	− 7. 3·56
			Polaris, 8·875 (8)	1. 16. 45·13	50·80	} 51·80	7. 4·22
		W	,, 8·750 (9)	1. 24. 12·89	1·25		
			α Eridani	1. 40. 7·27	8·49	4·77	7. 3·72
			o Piscium	1. 45. 51·02	51·12	47·63	7. 3·49
			β Arietis	1. 54. 47·49	47·51	44·13	7. 3·38
		E	α Arietis	2. 7. 11·41	10·98	7·78	7. 3·20
			ξ¹ Ceti	2. 13. 26·36	26·08	22·73	7. 3·35
			67 Ceti	2. 17. 48·86	48·71	45·23	7. 3·38
	24	E	Polaris, 9·250 (5)	1. 17. 48·30	48·97	} 49·70	7. 4·64
		W	,, 9·125 (6)	1. 22. 56·17	59·82		
			η Piscium	1. 31. 48·21	48·28	47·63	7. 0·66
			α Eridani	1. 40. 4·23	5·23	4·71	7. 0·52
			o Piscium	1. 45. 48·20	48·29	47·62	7. 0·67
			β Arietis	1. 54. 44·87	44·91	44·13	7. 0·78
			α Arietis	2. 7. 8·45	8·46	7·76	7. 0·70
			67 Ceti	2. 17. 45·66	45·87	45·21	7. 0·66
		E	ξ² Ceti	2. 29. 31·84	31·52	31·07	7. 0·45
			ν Ceti	2. 36. 20·16	19·85	19·15	7. 0·70
			δ Ceti	2. 40. 5·82	5·54	4·95	7. 0·59
			γ² Ceti	2. 43. 50·77	50·46	49·80	7. 0·66
			σ¹ Arietis	2. 51. 36·89	36·50	35·84	7. 0·66
			ε Arietis	2. 59. 5·33	4·89	4·35	7. 0·54
			Cephei 51, 8·750 (4)	6. 46. 54·37	38·67	} 41·04	6. 59·51
		W	,, 8·750 (4)	6. 50. 42·75	42·43		
			ε Canis Majoris	7. 0. 44·30	44·72	43·91	7. 0·81
1875. January	5	E	ν Orionis	6. 7. 0·83	0·62	27·11	6. 33·51
		W	δ Ursæ Min. S.P., 7·500 (7)	6. 15. 42·14	50·92	} 18·16	6. 32·75
		E	,, 7·500 (7)	6. 21. 49·10	50·91		
		W	Canopus	6. 27. 44·62	45·55	12·58	6. 32·97
			γ Geminorum	6. 37. 3·61	3·88	30·43	6. 33·45
			Sirius	6. 46. 12·09	12·55	39·37	6. 33·18
	10	E	ε Leporis	5. 6. 37·49	37·41	11·25	6. 26·16
			α Aurigæ	5. 13. 55·02	54·54	28·61	6. 25·93
			β Tauri	5. 24. 50·57	50·26	24·46	6. 25·80
			δ Orionis	5. 32. 4·20	4·05	38·23	6. 25·82
			α Columbæ (3)	5. 41. 34·80	34·76	8·81	6. 25·95
			α Orionis	5. 54. 51·38	51·20	25·28	6. 25·92
			1 Geminorum (4)	6. 2. 58·59	58·31	32·40	− 6. 25·91

Table IV.—Transits of Stars—*concluded.*

Day.	Micrometer E or W.	Object observed and (Number of Wires).	Mean observed Time by Chronometer N of Transit over the Center Wire.	Seconds of True Transit over the Meridian.	Seconds of Star's Assumed Apparent R.A.	Chronometer N apparently Slow.
1875.			h m s	s	s	m s
January 10	E	λ Ursæ Min. S.P., 11·250 (7).	7. 49. 20·57	29·50	57·62	− 6. 25·72
	W	,, 11·250 (7).	7. 59. 0·71	17·18		
12	E	ι Geminorum...............	6. 2. 55·75	55·53	32·40	6. 23·13
		ν Orionis..................	6. 6. 50·23	50·09	27·15	6. 22·94
		δ Ursæ Min. S.P., 12·750 (10)	6. 15. 12·18	44·38	19·15	6. 22·57
	W	,, 12·750 (10)	6. 21. 55·60	39·05		
		α Argûs....................	6. 27. 34·42	35·78	12·53	6. 23·25
		γ Geminorum...............	6. 36. 53·19	53·66	30·52	6. 23·14
		Sirius.....................	6. 46. 1·73	2·48	39·42	6. 23·06
		θ Canis Majoris............	6. 54. 46·54	47·24	24·08	6. 23·16
		ε Canis Majoris............	7. 0. 6·45	7·32	44·07	6. 23·25
		ζ Geminorum...............	7. 3. 5·61	6·06	42·90	6. 23·16
		51 Geminorum..............	7. 12. 35·35	35·82	12·78	6. 23·04
		δ Geminorum...............	7. 19. 3·45	3·89	40·68	− 6. 23·21

TABLE V.—COMPARISON of the STATIONARY CHRONOMETERS J, L, and N at WAIMEA.

Day and Approximate Local Mean Time.	Time by L (Solar).	Time by J (Sidereal).	Time by N (Sidereal).	Day and Approximate Local Mean Time.	Time by L (Solar).	Time by J (Sidereal).	Time by N (Sidereal).
1874. h m	h m s	h m s	h m s	1874. h m	h m s	h m s	h m s
Dec. 6, 22. 24	10. 34. 19·5	3. 42. 41·0	..	Dec. 10, 23. 9	11. 19. 15·0	..	16. 38. 30·0
	10. 37. 8·5	..	15. 40. 40·0		11. 23. 0·5	4. 47. 41·0	..
7, 11. 2	11. 11. 45·0	..	4. 17. 19·0	11, 11. 0	11. 9. 39·5	4. 36. 19·0	..
	11. 17. 25·0	4. 27. 55·0	..		11. 11. 48·5	..	4. 32. 59·0
7, 23. 16	11. 26. 0·0	4. 38. 33·0	..	23. 7	11. 17. 34·5	4. 46. 17·0	..
	11. 29. 12·5	..	16. 36. 47·0		11. 19. 44·0	..	16. 42. 53·0
8, 2. 0	2. 9. 35·5	7. 22. 36·0	..	12, 10. 18	10. 28. 51·5	..	3. 53. 49·0
	2. 12. 28·0	..	19. 20. 29·0	13.	1. 26. 22·5	6. 57. 28·0	..
3. 47	3. 57. 32·0	..	21. 5. 50·0	13, 0. 0	0. 0. 9·5	5. 33. 2·0	..
	3. 59. 20·0	9. 12. 39·0	..		0. 1. 37·0	..	17. 28. 47·0
9, 0. 25	0. 35. 2·5	..	17. 46. 42·0	10. 49	10. 59. 54·5	4. 34. 38·0	..
	0. 39. 51·5	5. 56. 40·0	..		11. 1. 45·0	..	4. 30. 42·0
11. 16	11. 26. 14·0	..	4. 39. 39·0	23. 22	11. 32. 17·5	5. 9. 8·0	..
	11. 27. 38·5	4. 46. 16·0	..		11. 34. 16·5	..	17. 5. 16·0
10, 9. 17	9. 27. 10·0	2. 49. 30·0	..	14, 11. 5	11. 15. 43·0	4. 54. 32·0	..
	9. 32. 44·5	..	2. 49. 45·0		11. 19. 28·5	..	4. 52. 22·0

Table V.—Comparison of the Stationary Chronometers—*concluded.*

Day and Approximate Local Mean Time.	Time by L (Solar).	Time by J (Sidereal).	Time by N (Sidereal).
1874. h m	h m s	h m s	h m s
Dec. 14, 23. 24	11. 34. 0·5	5. 14. 54·0	..
	11. 37. 54·5	..	17. 12. 48·0
15, 10. 33	10. 43. 48·0	4. 26. 34·0	..
	10. 46. 50·5	..	4. 23. 32·0
22. 27	10. 37. 16·0	..	16. 15. 53·0
	10. 40. 18·0	4. 25. 5·0	..
16, 11. 22	11. 42. 6·5	5. 29. 5·0	..
	11. 43. 50·5	..	5. 24. 35·0
22. 50	11. 0. 2·5	..	16. 42. 37·0
	11. 5. 41·0	4. 54. 35·0	..
17, 10. 1	11. 11. 1·0	5. 1. 57·0	..
	11. 12. 52·0	..	4. 57. 25·0
18, Noon	12. 2. 47·0	..	17. 49. 25·0
	12. 6. 40·0	5. 59. 47·0	..
10. 20	10. 30. 33·5	..	4. 18. 53·0
	10. 33. 13·5	4. 28. 6·0	..
22. 50	11. 0. 38·5	..	16. 51. 0·0
	11. 3. 2·0	5. 0. 1·0	..
19, 9. 45	9. 55. 37·0	..	3. 47. 45·0
	9. 58. 12·5	3. 57. 2·0	..
22. 57	11. 7. 32·0	..	17. 1. 49·0
	11. 11. 10·0	5. 12. 13·0	..
20, 4. 45	4. 54. 55·0	..	22. 50. 8·0
	4. 59. 29·5	11. 1. 31·0	..
22. 54	11. 4. 37·0	..	17. 2. 47·0
	11. 7. 25·5	5. 12. 30·0	..

Day and Approximate Local Mean Time.	Time by L (Solar).	Time by J (Sidereal).	Time by N (Sidereal).
1874. h m	h m s	h m s	h m s
Dec. 21, 10. 42	10. 52. 0·0	..	4. 52. 5·0
	10. 55. 14·5	5. 2. 18·0	..
22. 43	10. 53. 41·5	..	16. 55. 44·0
	10. 56. 32·0	5. 5. 37·0	..
22, 22. 45	10. 55. 23·5	..	17. 1. 21·0
	10. 58. 58·5	5. 12. 6·0	..
23, 13. 41	1. 51. 6·5	8. 6. 44·0	..
	1. 53. 32·0	..	8. 1. 55·0
24, 13. 14	1. 24. 24·5	..	7. 36. 37·0
	1. 28. 7·0	7. 47. 43·0	..
1875. Jan. 4, 23. 44	11. 54. 54·5	..	18. 51. 38·0
	11. 58. 25·0	7. 4. 12·0	..
5, 11. 55	0. 5. 15·0	..	7. 3. 57·0
	0. 7. 36·5	7. 15. 26·0	..
23. 49	11. 59. 51·5	..	19. 0. 30·0
	0. 2. 14·5	7. 12. 4·0	..
9, 22. 18	10. 28. 18·5	5. 53. 59·0	..
	10. 31. 35·0	..	17. 47. 35·0
10, 13. 0	1. 10. 20·5	..	8. 28. 43·0
	1. 12. 45·0	8. 40. 54·0	..
23. 35	11. 45. 17·0	..	19. 5. 23·0
	11. 47. 22·0	7. 17. 18·0	..
11, 4. 3	4. 13. 35·5	..	23. 34. 25·0
	4. 15. 32·0	11. 46. 13·0	..
12, 12. 0	0. 9. 56·5	..	7. 35. 57·0
	0. 11. 45·0	7. 47. 48·0	..

TABLE VI.—ERRORS and RATES of the SIDEREAL CHRONOMETER N at WAIMEA by OBSERVATION.

Solar Day.		Sidereal Time.	Chronometer N Slow.	Loss in the preceding 24^h Sidereal.	Adopted Losing Rate.
1874.		h m	m s	s	s
December	6	1. 10	− 7. 39·74	+ 1·57	+ 1·72
	7	1. 59	7. 37·81	1·86	1·79
	8	3. 58	7. 35·92	1·72	2·07
	9	2. 44	7. 33·62	2·42	2·19
	10	1. 12	7. 31·80	1·95	1·97
	11	1. 16	7. 29·81	1·99	2·42
	12	5. 3	− 7. 26·51	+ 2·86	+ 2·62

Table VI.—Errors and Rates of the Sidereal Chronometer N at Waimea by Observation—*concluded.*

Solar Day.		Sidereal Time.	Chronometer N Slow.	Loss in the preceding 24^h Sidereal.	Adopted Losing Rate.
1874–5.		h m	m s	s	s
December	14	1. 38	− 7. 22·45	+ 2·02	+ 2·56
	15	2. 18	7. 19·25	3·13	2·74
	16	2. 53	7. 16·85	2·38	2·51
	18	2. 54	7. 10·78	3·39	2·82
	19	2. 21	7. 8·58	2·25	2·15
	21	2. 41	7. 4·78	1·72	1·56
	22	1. 44	7. 3·45	1·39	1·39
	24	2. 33	7. 0·65	1·38	1·38
January	2	3. 12	6. 38·15	2·49	1·38
	4	1. 43	6. 35·90*	1·16	1·80
	5	6. 15	6. 33·36	2·12	2·02
	10	5. 27	6. 25·93†	1·50	1·42
	12	6. 23	− 6. 23·10	+ 1·39	+ 1·39

* January 4. Transits observed with Micrometer W. only.
† January 10. Transits observed with Micrometer E. only.

TABLE VII.—ERRORS and RATES of the SIDEREAL CHRONOMETER J at WAIMEA INFERRED from TABLES V. and VI.

Approximate Local Mean Time.			Time by Chronometer J.	Chronometer J. Slow on Sidereal Time.	Loss in the preceding 24^h Sidereal.	Adopted Losing Rate.
1874–5.		h	h m	m s	s	s
December	6,	11·0	4. 6	− 12. 26·20	− 6·67	− 6·52
	7,	11·1	4. 28	12. 32·67	6·38	6·45
	8,	3·8	21. 13	12. 37·22	6·52	6·51
	9,	11·3	4. 46	12. 45·72	6·49	6·73
	10,	9·2	2. 46	12. 52·11	6·97	6·61
	11,	10·9	4. 33	12. 58·82	6·26	6·16
	12,	13·3	6. 57	13. 5·48	6·07	6·11
	13,	10·8	4. 32	13. 11·01	6·15	6·63
	14,	11·0	4. 51	13. 18·23	7·12	6·52
	15,	10·5	4. 24	13. 24·04	5·03	6·24
	16,	11·5	5. 26	13. 30·87	6·55	6·51
	17,	11·0	4. 59	13. 37·23	6·48	6·28
	18,	10·4	4. 28	13. 43·18	6·08	6·31
	19,	9·8	3. 57	13. 49·58	6·53	6·40
	21,	10·7	5. 2	14. 2·60	6·37	6·37
	22,	10·8	5. 9	14. 9·00	6·37	6·50
	24,	13·3	7. 48	14. 23·25	6·75	6·69
January	2,	10·8	5. 57	15. 20·61	(6·44)	6·61
	4,	11·9	7. 7	15. 34·20	6·65	6·33
	5,	12·0	7. 15	15. 40·41	6·17	6·18
	10,	13·0	8. 41	16. 11·86	(6·22)	6·64
	12,	12·0	7. 47	− 16. 25·24	− 6·81	− 6·81

TABLE VIII.—ERRORS and RATES of the MEAN SOLAR CHRONOMETER L at WAIMEA, INFERRED from TABLES V. and VI.

Day.		Local Mean Time.	Chronometer L Slow on Local Mean Time.	Loss in the preceding 24^h Solar.	Adopted Losing Rate.
1874–5.		h m	m s	s	s
December	6	11. 7	− 9. 58·01	− 0·49	− 0·40
	7	11. 2	9. 58·32	0·31	0·26
	8	3. 44	9. 58·47	0·22	0·18
	9	11. 13	9. 58·67	0·15	0·43
	10	9. 23	9. 59·33	0·71	0·64
	11	11. 2	9. 59·94	− 0·57	− 0·12
	12	11. 16	9. 59·60	+ 0·34	+ 0·10
	13	10. 52	9. 59·64	− 0·04	− 0·45
	14	11. 9	10. 0·50	0·86	0·50
	15	10. 37	10. 0·63	0·13	0·29
	16	11. 34	10. 1·10	0·45	0·38
	17	11. 3	10. 1·41	0·31	0·06
	18	10. 21	10. 1·22	0·19	0·20
	19	9. 43	10. 1·42	0·20	0·39
	21	10. 39	10. 2·92	0·73	0·73
	22	10. 41	10. 3·53	0·61	0·77
	24	13. 11	10. 5·85	1·10	1·03
January	2	10. 55	10. 12·06	(0·70)	0·99
	4	11. 50	10. 14·19	1·05	0·87
	5	11. 55	10. 14·97	0·78	0·83
	10	13. 0	10. 20·40	1·09	1·21
	12	11. 59	− 10. 22·87	− 1·26	− 1·26

TRANSIT OF VENUS, 1874.

PART II.

EXPEDITION TO EGYPT,

UNDER

CAPTAIN C. ORDE BROWNE,

(*LATE* ROYAL ARTILLERY).

SECTION I.
OBSERVATIONS ON THE MOKATTAM HILLS, NEAR CAIRO.
With Three Plates.

SECTION II.
LONGITUDE OF ALEXANDRIA.

SECTION III.
OBSERVATIONS AT SUEZ.
With One Plate.

TRANSIT OF VENUS, 1874.

PART II.

EXPEDITION TO EGYPT.

Section 1.

OBSERVATIONS ON THE MOKATTAM HILLS, NEAR CAIRO.

With Three Plates.

PART II.

EXPEDITION TO EGYPT.

SECTION I.—OBSERVATIONS ON THE MOKATTAM HILLS, NEAR CAIRO.

INTRODUCTION.

Transit of Venus, 1874 Dec 8.

Plan of the Environs of Cairo showing the position of Captain Orde Browne's Encampment on Jebel Jeushi, Mokattam Range.

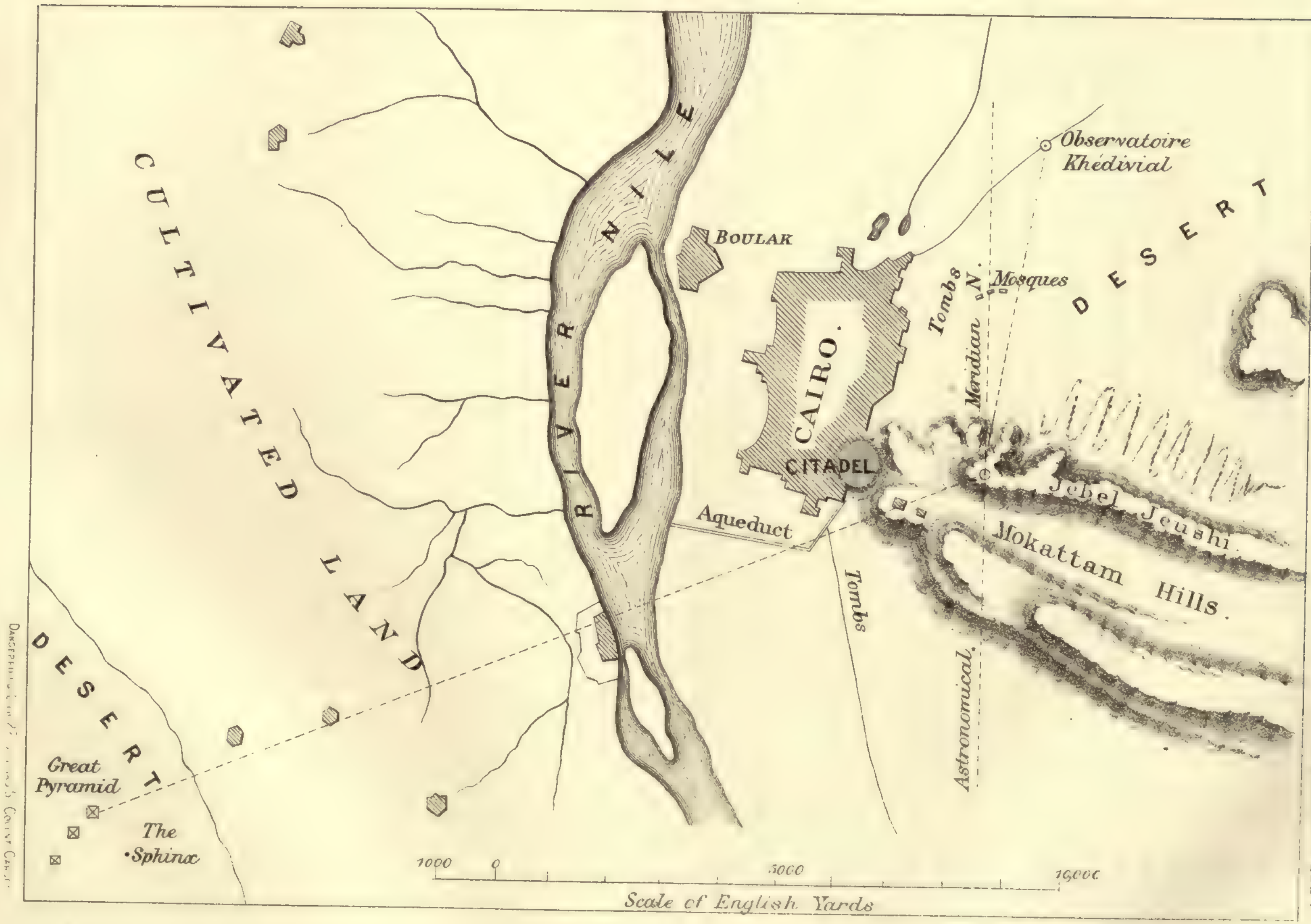


Plate VIII.

THE EXPEDITION TO EGYPT.

Section I.—Observations at Mokattam, near Cairo.

INTRODUCTION.

Shortly after my arrival in Egypt, through the kind offices of General Stanton, the British Consul-General, His Highness the Khedive was graciously pleased to accord me an interview, at which he expressed his sympathy with our undertaking, and his desire to further in every possible way the object of the Expedition. We were afterwards greatly indebted to His Highness for services which were not confined to such as may be classed under ordinary assistance—great expense having been incurred by him in providing transports, guards, and material.

On 1874, October 17, the entire expedition was assembled in Cairo. Having with mature consideration selected a site on the Mokattam Hills, an encampment was formed there on October 21. On October 27 the parties destined for Thebes took their departure from Cairo, and Mr. Hunter proceeded to Alexandria.

Our party on the Mokattam Hills consisted of F. M. Newton, Esq., Miss Emily M. Newton, myself, and my wife, with servants, and a guard of Egyptian soldiers. The work done at the station may be thus summarised :—

Observations for local time were continuous from October 24 to December 21; determinations of co-latitude were made November 4, 5, 27, 28; telegraphic signals for longitude were exchanged—

(1) with Greenwich (through Alexandria and Porthcurno), November 14, 15, 21, and 22;

(2) with Dr. Auwers at Luxor, December 1, 4, 10, and 15;

(3) with Mr. Hunter at Suez, December 4, 5, 7, and 14.

The camp at Mokattam was struck December 25.

The Site on the Mokattam Hills. (Plates VIII. and IX.)

The site selected, with the friendly assistance of Weyman Dixon, Esq., of Cairo, who was intimately acquainted with the country, was on the western

extremity of the ridge known as JEBEL JUISHI, which has the advantage of being elevated about 600 feet above the plain of Cairo, and for this reason was tolerably free from the mist that usually hung about the river and low grounds. There was a road leading more than half-way up the hill to some quarries, and a rough path the remainder of the way, over which country carts could be taken with difficulty. Telegraphic communication with the citadel was easily established with the assistance of Salamah Bey, Chief Engineer of Egyptain Telegraph lines.

The northern meridian was clear to the horizon, and horizontal ground to the eastward in the immediate vicinity of the station permitted the *Model* to be placed where it could be conveniently observed with all the telescopes.

The general position of the station is shown in Plate VIII.; the entire encampment and relative positions of the instruments in Plate IX. The exact position of the Transit instrument, with regard to prominent features of the surrounding country, is fixed by the following bearings taken with the Altazimuth, which was mounted for that purpose over the center of the Transit Pier. The bearings are reckoned from North through East, South, and West. The North Meridian line fell upon parts of two Mosque-tombs in the same field of view of the telescope as represented in Sketch N, Plate IX.

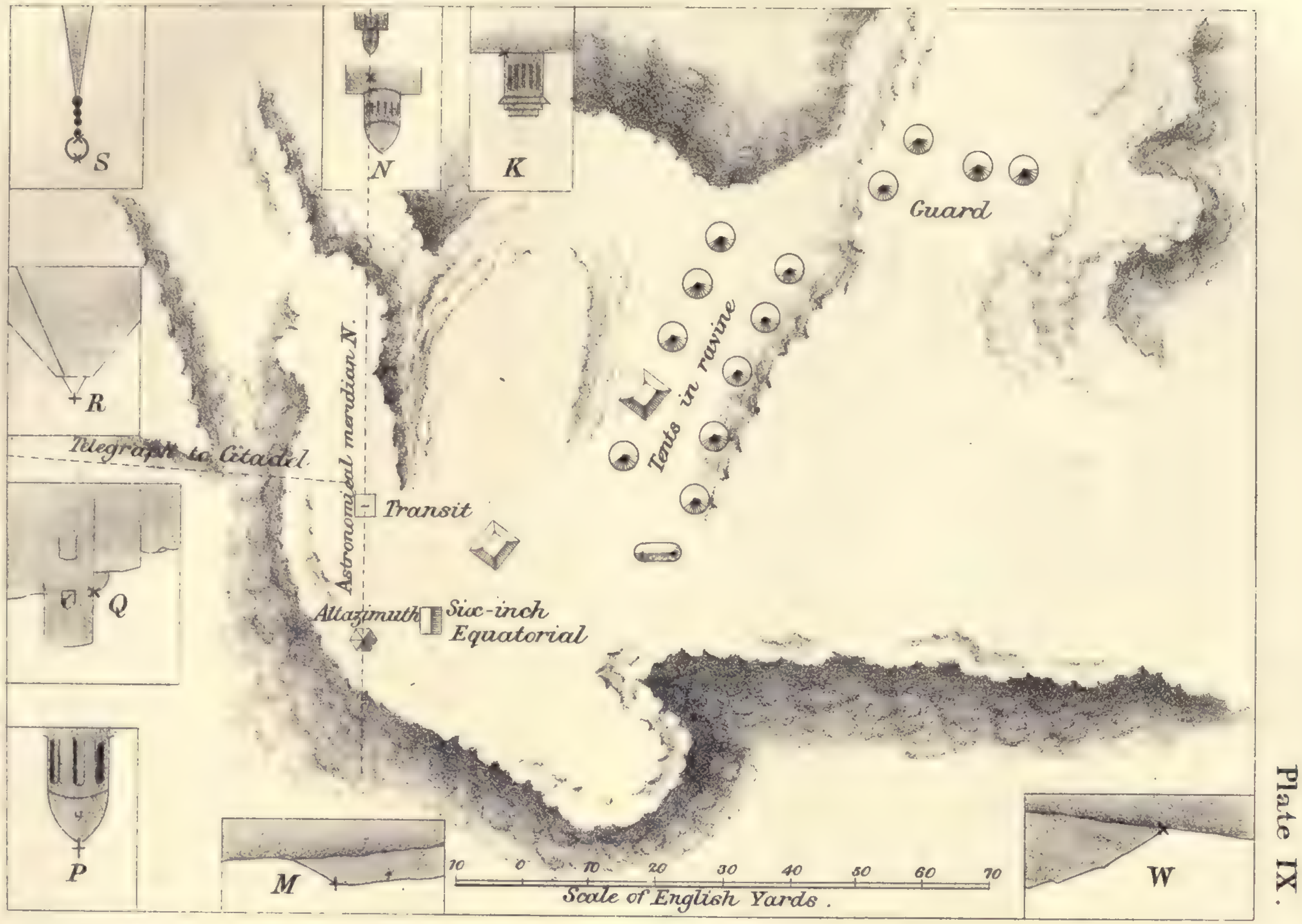
	°	′
North Meridan Marks (Sketch N, Plate IX.)	0.	0
Equatorial Drum of the Khedival Observatory (Sketch K)	10.	13
The Point marked in Sketch W.	115.	44
The Point marked in Sketch M.	156.	16
Summit of ruined Mosque near Fort Mokattam (Sketch P)	231.	6
An angle of the Tower of Fort Mokattam (Sketch Q)	243.	5
Geometrical Summit of the GREAT PYRAMID (Sketch R)	248.	23½
Vane of Minaret of Mosque of Mohammed Ali in the Citadel (Sketch S)	270.	5

The position of the center of the transit axis was permanently marked in the following manner:—The stones being removed, a hole was bored in the rock, a few inches deep, in which a small piece of iron was inserted and fixed with Portland cement; this was covered with layers of cement, sand, and soft surface rock. Probably, by reference to the plan and bearings, no difficulty would be experienced in recovering the spot. The transit piers were left standing on the slab to the immediate South of their old position, but were liable to be soon broken up and carried away.

C. ORDE BROWNE.

Transit of Venus 1874 Dec. 8.

Plan of the Encampment on Mokattam Heights near Cairo Latitude of the Altazimuth pier 30° 1′ 46·4″ N. Longitude 2h. 5m. 6s.·24 East of Greenwich.



The small sketches represent the objects, as seen in an inverting telescope, the bearings of which were taken from the Centre of the Transit Pier

The *Transit instrument*, with its fittings, mounting, and stone piers, and the *Transit Clock*, with its solid tripod stand, were in every respect exactly similar to the Honolulu instruments already described. The wooden observatory, 13 feet square, was also similar.

The great stone upon which stood the vertical piers was bedded in Portland cement laid on the surface of the solid rock. Observations for local time were commenced October 24.

The stars observed for clock-error were taken generally from the list employed at the Royal Observatory, Greenwich, the Right Ascensions being brought up from the Greenwich Catalogue of 2760 Stars for the Epoch 1864. For the determination of azimuth-error the stars α, δ, λ Ursæ Minoris, or Cephei (Hev.) 51, were employed.

The *value of one revolution of the transit-micrometer-screw* (which carried all the wires of the reticule) was found by numerous observations of *Polaris* to be $56''\cdot43$. The integer revolutions of the screw were numbered in the observing-books so as to increase towards the screw-head; the optic axis coincided approximately with the center wire when the reading was $19^{r}\cdot7$ (*see* Table XIV.). The position of the transit axis is always denoted by the record of the micrometer-screw-head being on the East or West side of the telescope.

The system of wires remained perfect during the observations, and the *equatorial intervals of the five vertical wires* from the center wire were found from the transits of 150 time-stars as follows :—

		s
Wire	I. (nearest to the screw-head)....	28·610
„	II.	14·143
„	III.	0·000
„	IV.	14·196
„	V. (farthest from the screw-head).	28·581

The imperfect transits are very few in number, and all the observations of the polar stars were made at the center wire.

The mean of the five wires has been considered as sensibly coincident with the center wire.

The *Error of Level* (Table XIII.) was found with the hanging spirit-level. The value of the graduations engraved on the glass bubble was tested by the makers before the Expedition left England, when it was found that 50 divisions were equivalent to one minute of arc, which value has been always used.

The *Pivot Correction* was determined by repeated reversals of the instrument as follows :—

1874, June	18,	0·651	divisions	A positive level-error was greater with the Micrometer East than with the Micrometer West.
	23,	·038 ?	„	
	24,	·879	„	
	25,	·990	„	
	29,	·976	„	
	30,	·900	„	
July	1,	·759	„	

The pivot correction applied to the level-error determined by spirit-level is $-0''\cdot94$ Micrometer *East* and $+0''\cdot94$ Micrometer *West*.

The *Zero of Collimation* has been obtained from observations of circumpolar stars with reversed positions of the transit axis (Table XIV.).

The *Error of Azimuth* (Table XV.) has been found in the usual way, by combining the observed transits of two stars, one of which was near the pole.

The transits of stars (Table XVI.) have been reduced as described in Part I., page 15. The table contains only the transits observed in connection with important operations, such as longitude signals and the actual transit of *Venus*. When a transit was imperfect, or less than five bisections of a polar star with the micrometer were obtained, the number of wires, or bisections, observed is indicated by a numeral attached to the star's name thus : "ϵ Eridani (4)." For the polar stars the mean micrometer-reading corresponding to the mean observed clock-time is also given with the star's name, and the micrometer-setting for Clock Stars is given at the foot of the page.

For the *diurnal aberration* a constant ($-0''\cdot27$) has been embodied in the correction for Collimation ; the tabular Right Ascensions in Column 7 are therefore not affected by it. When a circumpolar star has been observed with both positions of the instrument, each observation is separately reduced, and the clock-slow for such observations is deduced, to exhibit the accuracy or otherwise of the instrumental corrections.

The *adopted error of the transit clock* (Table XVII.) is the simple mean of all the errors obtained on the day (omitting of course those obtained from polar stars), and corresponds to the mean of the observed sidereal time in Column 3. The *adopted losing rate* in Column 6 is the mean of the observed loss in the 24 hours preceding and following, and also corresponds to the mean of the times. When the interval of time for which clock rate has to be allowed for any species of observation exceeds six hours, the "loss in 24 hours" in Column 5

has been used as the rate. Generally the interval is less than six hours, and the "Adopted Rate" has been used.

ZENITH DISTANCES OBSERVED AT MOKATTAM, AND INFERRED CO-LATITUDE. (Table XIX.)

The Vertical Circle, or Altazimuth, used at Mokattam was similar in every respect to the Honolulu instrument. It was mounted on a pier of masonry founded on the solid rock, and was protected by a wooden hut with a revolving roof.

The mean corrections to the reading of the Vertical Circle for runs of the four Micrometer screws for 100″ were—

1874, November 4,	$+ 0''.09$
5,	$- 0.76$
27,	$+ 0.05$
28,	$- 0.17$

The two levels parallel to the plane of the Vertical Circle were each graduated with 30 divisions to one minute of arc. The *Level Indication* is half the sum of the four readings. The *Mercurial Barometer* and the *External Thermometer*, both by Messrs. Horne and Thornthwaite, were verified at the Royal Observatory, Greenwich, and require no correction. The *refractions* have been computed from the tables forming the *Appendix* to the *Greenwich Observations* for 1853, and then reduced in the proportion of 1·0053 : 1.

The comparisons by which the error of the Altazimuth Clock was obtained are given in Table XVIII. The error is required only for computing the *Reduction to the Meridian.*

Co-latitude of Mokattam Station (Table XIX.)—

Mean of 6 Stars North of Zenith,	$59^{\circ}.\ 58'.\ 14''\!\cdot\!2$ N.
„ 6 „ South „	59. 58. 13·1

Adopted Co-latitude of the Altazimuth Pier, 59°. 58′. 13″·6 N.

G. L. T.

LONGITUDE OF MOKATTAM STATION, BY WILLIAM ELLIS, ESQ., OF THE ROYAL OBSERVATORY, GREENWICH, AND CAPTAIN C. ORDE BROWNE.

In introducing this section our first duty is to acknowledge the great obligations of the Expedition to JOHN PENDER, Esq., M.P., Sir JAMES ANDERSON, and the DIRECTORS of the EASTERN TELEGRAPH COMPANY, who gratuitously gave the use of their submarine cables extending from Porthcurno in Cornwall to Alexandria, for preliminary experiments, as well as for the final series of signals, notwithstanding the serious interruption of the ordinary business thereby entailed. The necessary "joining up" of the five separate cables, and the transmission of time signals through such a length of wire that *speaking* was excessively inconvenient, was a very serious matter, but the operations were entirely successful, owing chiefly to the personal superintendence and forethought of Mr. EDWARD BULL, the Superintendent at Porthcurno.

Material aid was rendered by Mr. CROMWELL VARLEY, F.R.S., who kindly lent his artificial cable, consisting of a large resisting coil and apparatus, by which preliminary practice was obtained at Greenwich in the special character of signal required. Mr. Varley also suggested the system of signalling, distinguished hereafter as "Varley's method."

The first object of the preliminary experiments at Porthcurno was to ascertain the possibility of obtaining a reliable signal through the great length of cable between that place and Alexandria, which, it may be remarked, is not only 638 knots longer than the Transatlantic cable used in the determination of the longitude of Washington, but has also a much smaller section of copper.*

It was further necessary to decide on the arrangement of apparatus to be employed, and to take steps to ensure that the same conditions should be observed both at Porthcurno and Alexandria when the actual experiment should take place. It was found that when Thomson's reflecting galvanometer was employed in the usual way, the movement of the beam of light was feeble, but that with an arrangement proposed by Mr. Bull an amply sufficient length of travel was obtained. This arrangement consisted in the attach-

* The Porthcurno and Alexandria cable is 3,222 *knots*, and the French cable from Brest to St. Pierre 2,584 *knots*, in length. The weights of copper wire and gutta-percha coating are respectively 120 lbs. and 175 lbs. per knot for the English, and 400 lbs. of copper and of gutta-percha together for the French cable.

ment of the small mirror to the coil of a Thomson's syphon recorder, by which its action was rendered much more sensitive than when used on the ordinary galvanometer, by being brought into a strong magnetic field.*

Experiments were made with and without condensers. When no condenser was used on the cable, the beam came to no fixed zero position, but was subject to continual fluctuation. On the other hand, when a condenser was employed at the sending end, the motion of the beam of light was not sufficient to furnish a reliable signal.

The following was the arrangement finally adopted:—A condenser was employed at the receiving end of the cable only—between the line and the recording instrument. The mirror was used on the recorder in the manner proposed by Mr. Bull, who also provided a similar instrument for use at Alexandria in order to ensure the same conditions being observed at both ends of the cable.

The same amount of line battery was used throughout both at Porthcurno and at Alexandria, namely, 40 cells of Menotti or Daniell. Signals, however, were received at Porthcurno from Alexandria, to test the sensitiveness of the instrument, with 12 Menotti cells, and messages were read from Gibraltar with 3 Menotti cells. To keep up the magnetic field, 10 and 12 large batteries of the Daniell form were used, the size of the zinc plates being about 1 foot square, and the resistance of the electro-magnet about 16 ohms.

The following are the particulars of the cables employed:—

Porthcurno to Vigo, 620 knots.
Vigo to Lisbon, 247 knots.
Lisbon to Gibraltar, 331 knots.
Gibraltar to Malta, 1,120 knots.
Malta to Alexandria, 904 knots.

The electrostatic capacity of the cable is 0·3645 microfarad per knot. Specific inductive capacity of insulator, 0·0729 microfarad.

All possible assistance in Egypt was rendered by Mr. GIBBS, the Superintendent; by Mr. STEVENSON, at Alexandria; and by Messrs. CROSS and ROGIERRI, at Mokattam.

The Post Office Telegraph Department, represented by Mr. EATON, cordially

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* In the Thomson recorder a coil of very fine wire is suspended vertically between the extremities of a powerful electro-magnet depending on the action of a special battery. The coil is brought into the actual line circuit; hence a slight current through the line causes strong movement of the coil.

co-operated in completing the land line arrangements between Greenwich and Porthcurno.

The longitudes of all the stations in Egypt at which observations of the Transit of *Venus* were made in connexion with the British Expedition depend fundamentally on that of Mokattam, the Mokattam Station being temporarily connected with Alexandria by erecting a line from the citadel of Cairo to that station. As it is unadvisable, with due regard to the safety of a submarine cable, to attach thereto a land wire, it became necessary to divide the whole line from Greenwich to Mokattam into sections, and make exchanges of galvanic signals independently on each. The line naturally divided itself into three sections: Greenwich—Porthcurno, Porthcurno—Alexandria, and Alexandria—Mokattam. The days selected for exchanging signals were, 1874, November 14, 15, 21, and 22. On each of these days work was commenced by making exchanges of signals between Greenwich and Porthcurno, and between Alexandria and Mokattam. These went on nearly simultaneously, and they were followed by exchanges between Porthcurno and Alexandria, which occupied several hours. Finally, for security, a further exchange was made between Alexandria and Mokattam, but that between Greenwich and Porthcurno was not repeated. The exchange of November 14 combined with that of November 15, and the exchange of November 21 combined with that of November 22, gave, however, all requisite information in regard to the rates of the chronometers used at Porthcurno.

The signals were given at all stations by means of an ordinary pair of positive and negative keys. Those received on land lines were observed on an ordinary upright galvanometer; those received on the cable were observed by use of a reflecting galvanometer, constructed, as before mentioned, by fixing a light mirror to a Thomson's syphon recorder (the instrument employed for the speaking work). The cable of the Eastern Telegraph Company, as before mentioned, consists of sections as follows:—1st, Porthcurno to Vigo; 2nd, Vigo to Lisbon; 3rd, Lisbon to Gibraltar; 4th, Gibraltar to Malta; and 5th, Malta to Alexandria. But, for the longitude work, the whole of these were joined up into one continuous cable, without break or instrument of any kind in circuit, and the signals were passed directly from Porthcurno to Alexandria, or the reverse, through the whole length of cable. The clock used at Greenwich for giving and receiving signals was the Sidereal Standard (by which Greenwich time was determined). At Porthcurno a mean solar chronometer (C. Frodsham 3205) was used for signalling with Greenwich, and a sidereal chronometer (Reid and Sons 1207) for signalling with Alexandria. At Alexandria a mean solar chronometer (Hewitt 890) was alone used. At Mokattam the sidereal clock Dent 1914 was used

(by which Mokattam time was determined). It will be thus seen that signals given by a sidereal clock or chronometer would be observed by a solar chronometer, and *vice versâ*, so that (on account of the acceleration of sidereal on solar time) the observer receiving signals would, in all cases, register every variety of fraction of second. The observer at Porthcurno of course made numerous comparisons of his two chronometers by the method of coincidence of beats.

For further details concerning the methods of observation and reduction employed the reader is referred to the notes and explanations attached, as seemed desirable, to the various tables that follow.

TABLE I.—ERRORS and RATES of the SIDEREAL STANDARD CLOCK of the ROYAL OBSERVATORY, GREENWICH.

Day, Astronomical, 1874.	Observer.	Name of Star.	Time by Sidereal Standard.	Sidereal Standard Clock Slow.	Sidereal Standard Clock Slow reduced to Standard Observer Criswick.	Mean of Times.	Mean Clock Slow reduced to Standard Observer Criswick.	Daily Losing Rate.
			h m	s	s	h m	s	s
Nov. 14	AD	α Andromedæ	0. 1	+31·90	+31·93			
		γ Pegasi	0. 6	+31·95	+31·98			
		ε Andromedæ	0. 31	+32·11	+32·14			
		δ Piscium	0. 41	+31·96	+31·99	0. 41	+31·95	
		20 Ceti	0. 46	+31·90	+31·93			
		α Arietis	1. 59	+31·73	+31·76			
15	C	σ Arietis	2. 44	+31·84	+31·84			−0·07
		ε Arietis	2. 51	+31·94	+31·94	2. 53	+31·87	
		α Ceti	2. 55	+31·82	+31·82			
		δ Arietis	3. 3	+31·87	+31·87			
Nov. 19	C	Arcturus	14. 9	+31·26	+31·26			
20		ε Andromedæ	0. 31	+31·19	+31·19			
		ο Piscium	1. 38	+31·25	+31·25			
		β Arietis	1. 47	+31·17	+31·17	0. 24	+31·22	
		A^1 Tauri	3. 56	+31·25	+31·25			
		ε Tauri	4. 20	+31·19	+31·19			
22	C	α Andromedæ	0. 1	+31·18	+31·18			+0·01
		γ Pegasi	0. 6	+31·29	+31·29			
	M	ε Andromedæ	0. 31	+31·30	+31·19			
		β Andromedæ	1. 2	+31·29	+31·18			
	AD	ε Arietis	2. 51	+31·25	+31·28			
		α Ceti	2. 55	+31·23	+31·26	2. 15	+31·24	
		ο Tauri	3. 17	+31·22	+31·25			
		f Tauri	3. 23	+31·25	+31·28			
		ε Eridani	3. 26	+31·19	+31·22			
		δ Eridani	3. 36	+31·12	+31·15			
		η Tauri	3. 39	+31·29	+31·32			

The initials C, A D, and M are, respectively, those of Messrs. Criswick, Downing, and Maunder, Assistants of the Royal Observatory. Mr. Criswick is adopted as standard. The corrections applied to the "clock-slow" obtained by Messrs. Downing and Maunder are respectively $+0^{s}\cdot03$ and $-0^{s}\cdot11$. These are the quantities determined from a discussion of the whole of the observations taken by these observers during the year 1874. See *Greenwich Observations* for 1874, page lii.

The adopted values of the Royal Observatory Sidereal Standard Clock slow are as follows :—

Approximate Greenwich Mean Solar Time of Exchange of Galvanic Signals with Porthcurno.	Time by Sidereal Standard.	Sidereal Standard Clock Slow reduced to Standard Observer (C).
h	h m	s
1874, November 14, 11	2. 40	+ 31·94
15, 7	22. 50	+ 31·88
21, 11	3. 7	+ 31·23
22, 7	23. 5	+ 31·24

These values are used (*see* Table II.) to infer the error of the chronometer C. Frodsham 3205, at Porthcurno.

TABLE II.—DETERMINATION of the ERROR of the Mean Solar Chronometer C. FRODSHAM 3205, at PORTHCURNO, on GREENWICH MEAN SOLAR TIME, by exchange of GALVANIC SIGNALS between GREENWICH and PORTHCURNO.

Approximate Greenwich Mean Solar Time.	Station giving Signals.	Whether Positive or Negative Signals were given.	No. of Group.	No. of Signals in Group.	At Greenwich. Means of the Separate Groups of Signals by Sidereal Standard Clock.	At Greenwich. Sidereal Standard Clock Slow.	At Porthcurno. Means of the Separate Groups of Signals by Chronometer C. Frodsham 3205 (Mean Solar).	At Porthcurno. Resulting Error of C. Frodsham 3205, Slow on Greenwich Mean Solar Time.
1874. h					h m s	s	h m s	m s
Nov. 14, 11	G	Positive	1	53	2. 16. 45·00	+31·94	10. 40. 0·22	+1. 51·02
	P	Positive	2	59	2. 32. 17·34	+31·94	10. 55. 30·00	+1. 51·03
	G	Negative	3	49	2. 48. 30·00	+31·94	11. 11. 40·01	+1. 51·02
	P	Negative	4	55	3. 3. 37·58	+31·94	11. 26. 45·00	+1. 51·14
Nov. 15, 7	G	Positive	5	55	22. 25. 45·00	+31·88	6. 45. 40·93	+1. 52·18
	P	Positive	6	59	22. 41. 36·78	+31·88	7. 1. 30·00	+1. 52·28
	G	Negative	7	49	22. 57. 30·00	+31·88	7. 17. 20·65	+1. 52·25
	P	Negative	8	55	23. 14. 27·26	+31·88	7. 34. 15·00	+1. 52·39

Approximate Greenwich Mean Solar Time.	Station giving Signals.	Whether Positive or Negative Signals were given.	No. of Group.	No. of Signals in Group.	At Greenwich.		At Porthcurno.	
					Means of the Separate Groups of Signals by Sidereal Standard Clock.	Sidereal Standard Clock Slow.	Means of the Separate Groups of Signals by Chronometer C. Frodsham 3205 (Mean Solar).	Resulting Error of C. Frodsham 3205, Slow on Greenwich Mean Solar Time.
1874. h					h m s	s	h m s	m s
Nov. 21, 11	G	Positive	9	53	2. 43. 0·00	+31·23	10. 38. 22·53	+2. 7·32
	P	Positive	10	55	2. 58. 55·24	+31·23	10. 54. 15·00	+2. 7·48
	G	Negative	11	59	3. 15. 30·00	+31·23	11. 10. 47·14	+2. 7·39
	P	Negative	12	59	3. 31. 15·62	+31·23	11. 26. 30·00	+2. 7·57
Nov. 22, 7	G	Positive	13	51	22. 40. 30·00	+31·24	6. 32. 34·40	+2. 9·28
	P	Positive	14	61	22. 56. 28·42	+31·24	6. 48. 30·00	+2. 9·47
	G	Negative	15	53	23. 12. 30·00	+31·24	7. 4. 29·08	+2. 9·35
	P	Negative	16	57	23. 28. 33·75	+31·24	7. 20. 30·00	+2. 9·55

The observer at the sending station made contacts at intervals of 15 seconds; the times not fractional indicate means of times of contacts, a few in each group being usually omitted to make the mean identical with the time of some one particular contact.* The fractional times are the means of the observed times of the corresponding signals at the receiving station, as noted on an ordinary upright galvanometer. The signals were observed at Greenwich by eye and ear in the same manner as at Porthcurno, the sidereal chronometer in the Computing Room, sympathetic with the sidereal standard and chronograph, being used.

TABLE III.—MEAN ERRORS on GREENWICH MEAN SOLAR TIME, and RATES of the Mean Solar Chronometer C. FRODSHAM 3205, at PORTHCURNO, deduced from the separate Determinations of the preceding Table.

Time by Chronometer C. Frodsham 3205.	C. Frodsham 3205 Slow on Greenwich Mean Solar Time.	Daily Losing Rate.
1874. h m	m s	s
November 14, 11. 4	+ 1. 51·05	+ 1·47
15, 7. 10	+ 1. 52·28	
November 21, 11. 3	+ 2. 7·44	+ 2·38
22, 6. 57	+ 2. 9·41	

The errors of the chronometer C. Frodsham 3205 used in Table IV. depend on the fundamental determinations of Table III.

* It would frequently happen that one or two signals in a group would be lost; in such cases one or two others would be omitted, as mentioned above, to make the group symmetrical, and so lessen the labour of taking means.

TABLE IV.—COMPARISON at PORTHCURNO of the Chronometers C. FRODSHAM 3205 (Mean Solar) and REID AND SONS 1207 (Sidereal), by Coincidence of Beats, for Determination of the ERROR of REID AND SONS 1207 on GREENWICH SIDEREAL TIME.

Approximate Greenwich Mean Solar Time.	Time by C. Frodsham 3205 (Mean Solar).	C. Frodsham 3205 Slow on Greenwich Mean Solar Time.	Time by Reid and Sons 1207 (Sidereal).	Resulting Error of Reid and Sons 1207, Slow on Greenwich Sidereal Time.
1874. h	h m s	m s	h m s	m s
November 14, 9	9. 2. 27·0	+ 1. 50·93	0. 41. 45·0	− 2. 17·39
9	9. 5. 27·0	+ 1. 50·93	0. 44. 45·5	− 2. 17·40
10	9. 38. 21·0	+ 1. 50·96	1. 17. 45·0	− 2. 17·47
12	11. 41. 5·5	+ 1. 51·09	3. 20. 50·0	− 2. 17·67
12	11. 44. 5·0	+ 1. 51·09	3. 23. 50·0	− 2. 17·69
12	11. 47. 4·5	+ 1. 51·09	3. 26. 50·0	− 2. 17·69
12	12. 16. 49·5	+ 1. 51·12	3. 56. 40·0	− 2. 17·77
13	12. 37. 46·0	+ 1. 51·15	4. 17. 40·0	− 2. 17·80
November 14, 16	16. 24. 25·0	+ 1. 51·38	8. 4. 57·0	− 2. 18·35
16	16. 27. 20·0	+ 1. 51·38	8. 7. 52·5	− 2. 18·37
17	16. 45. 17·0	+ 1. 51·40	8. 25. 52·5	− 2. 18·40
17	17. 0. 15·0	+ 1. 51·41	8. 40. 53·0	− 2. 18·42
17	17. 3. 18·0	+ 1. 51·42	8. 43. 56·5	− 2. 18·42
19	18. 44. 18·0	+ 1. 51·52	10. 25. 13·5	− 2. 18·71
19	18. 47. 20·0	+ 1. 51·52	10. 28. 16·0	− 2. 18·72
November 15, 5	5. 7. 45·0	+ 1. 52·16	20. 50. 23·5	− 2. 18·66
5	5. 10. 51·0	+ 1. 52·16	20. 53. 30·0	− 2. 18·65
5	5. 13. 45·0	+ 1. 52·16	20. 56. 24·5	− 2. 18·68
8	8. 22. 59·0	+ 1. 52·36	0. 6. 10·0	− 2. 18·89
9	8. 37. 53·0	+ 1. 52·37	0. 21. 6·5	− 2. 18·93
9	8. 55. 55·0	+ 1. 52·39	0. 39. 11·5	− 2. 18·95
November 15, 10	9. 34. 40·0	+ 1. 52·43	1. 18. 3·0	− 2. 19·04
11	10. 31. 22·0	+ 1. 52·49	2. 14. 54·5	− 2. 19·17
12	12. 9. 55·0	+ 1. 52·59	3. 53. 44·0	− 2. 19·37
12	12. 13. 0·0	+ 1. 52·59	3. 56. 49·5	− 2. 19·36
November 21, 12	11. 50. 25·0	+ 2. 7·52	3. 58. 9·5	− 2. 23·77
12	11. 56. 25·0	+ 2. 7·52	4. 4. 10·5	− 2. 23·78
12	12. 2. 30·0	+ 2. 7·54	4. 10. 16·5	− 2. 23·76
12	12. 8. 37·0	+ 2. 7·55	4. 16. 24·5	− 2. 23·75
November 21, 17	17. 5. 6·0	+ 2. 8·04	9. 13. 43·0	− 2. 24·05
17	17. 8. 0·0	+ 2. 8·04	9. 16. 37·5	− 2. 24·08
17	17. 11. 6·0	+ 2. 8·05	9. 19. 44·0	− 2. 24·05
November 22, 6	5. 31. 45·0	+ 2. 9·27	21. 42. 26·0	− 2. 24·16
6	5. 34. 43·0	+ 2. 9·27	21. 45. 24·5	− 2. 24·18
6	5. 37. 44·0	+ 2. 9·27	21. 48. 26·0	− 2. 24·17
8	7. 39. 45·0	+ 2. 9·48	23. 50. 47·5	− 2. 24·41
8	7. 42. 46·0	+ 2. 9·49	23. 53. 49·0	− 2. 24·41
8	7. 45. 42·0	+ 2. 9·49	23. 56. 45·5	− 2. 24·43

Approximate Greenwich Mean Solar Time.	Time by C. Frodsham 3205 (Mean Solar).	C. Frodsham 3205 Slow on Greenwich Mean Solar Time.	Time by Reid and Sons 1207 (Sidereal).	Resulting Error of Reid and Sons 1207, Slow on Greenwich Sidereal Time.
1874. h	h m s	m s	h m s	m s
November 22, 12	12. 6.45·0	+ 2. 9·92	4.18.32·0	− 2.24·62
12	12. 9.42·0	+ 2. 9·92	4.21.29·5	− 2.24·63
12	12.15.45·0	+ 2. 9·94	4.27.33·5	− 2.24·62

The lines in the preceding table show the division into the groups from which the following mean errors of Reid and Sons 1207 are obtained.

TABLE V.—MEAN ERRORS and RATES of the Chronometer REID AND SONS 1207 (Sidereal) deduced from the Comparisons (at PORTHCURNO) with the Chronometer C. FRODSHAM 3205 (Mean Solar).

Approximate Greenwich Mean Solar Time.	Time by Reid and Sons 1207.	Reid and Sons 1207 Slow on Greenwich Sidereal Time			Hourly Losing Rate.
		By Comparison with C. Frodsham 3205.	As inferred from the Direct Determinations of its own Error.	Adopted Chronometer Slow.	
1874. h	h m	m s	m s	m s	s
Nov. 14, 11	2.39	− 2.17·61 (*a*)		− 2.17·61	−0·098
17	9. 0	− 2.18·48 (*b*)	− 2.17·98 (*i*)	− 2.18·23	
15, 7	22.38	− 2.18·79 (*c*)		− 2.18·79	−0·083
11	2.51	− 2.19·24 (*d*)	− 2.19·04 (*k*)	− 2.19·14	
Nov. 21, 12	4. 7	− 2.23·77 (*e*)		− 2.23·77	−0·043
17	9.17	− 2.24·06 (*f*)	− 2.23·91 (*l*)	− 2.23·99	
22, 7	22.50	− 2.24·29 (*g*)		− 2.24·29	−0·043
12	4.23	− 2.24·62 (*h*)	− 2.24·44 (*m*)	− 2.24·53	

The results (*a*), (*c*), (*e*), and (*g*) are obtained from comparisons with the chronometer C. Frodsham 3205 made near to times of determination of the error of the latter by the exchange of galvanic signals with Greenwich; they may, therefore, be adopted as fundamental determinations of the error of Reid and Sons 1207.

The results (*b*), (*d*), (*f*), and (*h*) depend upon a "chronometer slow" of C. Frodsham 3205, inferred from the fundamental errors of that chronometer given in Table III.; they are, therefore, affected with any possible irregularity of rate of that chronometer. The results (*i*) and (*k*) are inferred from those

of (a) and (c), and the results (l) and (m) from those of (e) and (g); these are similarly affected with any irregularity of rate of the chronometer Reid and Sons 1207 itself. That is to say, the results (b) and (i) depend, the former on the steadiness of rate of C. Frodsham 3205, the latter on the steadiness of rate of Reid and Sons 1207, and the mean of the two values may be adopted for the error of Reid and Sons 1207 at this epoch. Similarly for (d) and (k), for (f) and (l), and for (h) and (m).

The errors of the chronometer Reid and Sons 1207 used in Table VI. depend on the numbers contained in the fifth and sixth columns of the preceding table.

TABLE VI.—DETERMINATION of the ERRORS of the MEAN SOLAR CHRONOMETER HEWITT 890, at ALEXANDRIA, on GREENWICH MEAN SOLAR TIME, by exchange of GALVANIC SIGNALS between PORTHCURNO and ALEXANDRIA, through the SUBMARINE CABLE of the EASTERN TELEGRAPH COMPANY.

Approximate Greenwich Mean Solar Time.	Station giving Signals.	Whether Make or Break Signals were given or whether Varley's Method was employed.	No. of Group.	No. of Signals in Group.	At Porthcurno. Means of the separate Groups of Signals by Chronometer Reid and Sons 1207 (Sidereal).	At Porthcurno. Reid and Sons 1207 Slow of Greenwich Sidereal Time.	At Alexandria. Means of the separate Groups of Signals by Chronometer Hewitt 890 (Mean Solar).	At Alexandria. Resulting Error of Hewitt 890 Slow on Greenwich Mean Solar Time.
1874. h					h m s	m s	h m s	h m s
Nov. 14, 14	P	Make	17	10	5. 8. 18·00	− 2. 17·85	15. 27. 58·51	−1. 57. 51·69
„	P	Break	18	10	5. 7. 48·00	− 2. 17·85	15. 27. 28·53	−1. 57. 51·64
„	A	Make	19	18	5. 22. 9·77	− 2. 17·88	15. 41. 45·00	−1. 57. 48·72
„	A	Break	20	15	5. 22. 9·78	− 2. 17·88	15. 41. 45·00	−1. 57. 48·71
„	P	Make	21	15	5. 37. 0·00	− 2. 17·90	15. 56. 35·45	−1. 57. 51·39
„	P	Break	22	14	5. 36. 30·00	− 2. 17·90	15. 56. 5·56	−1. 57. 51·42
„	A	Make	23	17	5. 52. 29·96	− 2. 17·93	16. 12. 0·00	−1. 57. 48·55
„	A	Break	24	14	5. 52. 44·96	− 2. 17·93	16. 12. 15·00	−1. 57. 48·59
Nov. 14, 15	P	Varley's Method	25	14	6. 21. 30·00	− 2. 17·97	16. 40. 59·28	−1. 57. 52·58
„	A		26	14	6. 55. 11·21	− 2. 18·03	17. 14. 30·00	−1. 57. 47·67
16	P		27	20	7. 22. 30·00	− 2. 18·07	17. 41. 49·01	−1. 57. 52·41
„	A		28	19	7. 52. 50·87	− 2. 18·12	18. 12. 0·00	−1. 57. 47·54
17	P		29	12	8. 17. 30·00	− 2. 18·16	18. 36. 39·78	−1. 57. 52·28
„	A		30	10	8. 32. 27·51	− 2. 18·19	18. 51. 30·00	−1. 57. 47·46
Nov. 15, 8	P	Make	31	18	23. 58. 45·00	− 2. 18·90	10. 15. 18·43	−1. 57. 50·87
„	P	Break	32	12	23. 59. 0·00	− 2. 18·90	10. 15. 33·33	−1. 57. 50·81
9	A	Make	33	17	0. 14. 1·86	− 2. 18·92	10. 30. 30·00	−1. 57. 48·11
„	A	Break	34	18	0. 14. 31·78	− 2. 18·92	10. 31. 0·00	−1. 57. 48·27
„	P	Make	35	12	0. 29. 45·00	− 2. 18·94	10. 46. 13·33	−1. 57. 50·89
„	P	Break	36	20	0. 30. 0·00	− 2. 18·94	10. 46. 28·08	−1. 57. 50·68
„	A	Make	37	15	0. 45. 6·97	− 2. 18·96	11. 1. 30·00	−1. 57. 48·13
„	A	Break	38	12	0. 45. 21·90	− 2. 18·96	11. 1. 45·00	−1. 57. 48·24

Approximate Greenwich Mean Solar Time.	Station giving Signals.	Whether Make or Break Signals were given or whether Varley Method was employed.	No. of Group.	No. of Signals in Group.	At Porthcurno. Means of the separate Groups of Signals by Chronometer Reid and Sons 1207 (Sidereal).	At Porthcurno. Reid and Sons 1207 Slow of Greenwich Sidereal Time.	At Alexandria. Means of the separate Groups of Signals by Chronometer Hewitt 890 (Mean Solar).	At Alexandria. Resulting Error of Hewitt 890 Slow on Greenwich Mean Solar Time.
1874. h					h m s	m s	h m s	h m s
Nov. 15, 9	P	Varley's Method	39	12	1. 7. 30·00	— 2. 19·00	11. 23. 53·35	—1. 57. 52·15
10	A		40	14	1. 37. 16·49	— 2. 19·04	11. 53. 30·00	—1. 57. 47·24
,,	P		41	16	2. 3. 30·00	— 2. 19·08	12. 19. 43·95	—1. 57. 52·01
11	A		42	19	2. 33. 56·07	— 2. 19·12	12. 50. 0·00	—1. 57. 47·02
,,	P		43	20	3. 2. 30·00	— 2. 19·16	13. 18. 34·07	—1. 57. 51·87
12	A		44	12	3. 31. 35·63	— 2. 19·20	13. 47. 30·00	—1. 57. 46·99
Nov. 21, 13	P	Make	45	13	5. 34. 0·00	— 2. 23·83	15. 25. 54·18	—1. 57. 46·91
,,	P	Break	46	13	5. 34. 15·00	— 2. 23·83	15. 26. 9·09	—1. 57. 46·87
14	A	Make	47	23	5. 49. 41·00	— 2. 23·84	15. 41. 30·00	—1. 57. 44·32
,,	A	Break	48	24	5. 49. 40·93	— 2. 23·84	15. 41. 30·00	—1. 57. 44·39
,,	P	Make	49	21	6. 7. 0·00	— 2. 23·86	15. 58. 48·81	—1. 57. 46·98
,,	P	Break	50	17	6. 7. 15·00	— 2. 23·86	15. 59. 3·55	—1. 57. 46·77
,,	A	Make	51	22	6. 24. 46·77	— 2. 23·87	16. 16. 30·00	—1. 57. 44·33
,,	A	Break	52	21	6. 25. 1·74	— 2. 23·87	16. 16. 45·00	—1. 57. 44·40
Nov. 21, 15	P	Varley's Method	53	17	6. 47. 0·00	— 2. 23·88	16. 38. 43·61	—1. 57. 48·35
,,	A		54	19	7. 18. 26·74	— 2. 23·91	17. 10. 0·00	—1. 57. 43·19
16	P		55	14	7. 42. 30·00	— 2. 23·92	17. 34. 4·35	—1. 57. 48·24
,,	A		56	17	8. 7. 34·86	— 2. 23·94	17. 59. 0·00	—1. 57. 43·15
,,	P		57	25	8. 32. 0·00	— 2. 23·96	18. 23. 25·98	—1. 57. 48·01
17	A		58	17	8. 58. 43·38	— 2. 23·98	18. 50. 0·00	—1. 57. 43·05
Nov. 22, 8	P	Make	59	18	0. 29. 45·00	— 2. 24·36	10. 18. 31·49	—1. 57. 45·83
,,	P	Break	60	22	0. 30. 0·00	— 2. 24·36	10. 18. 46·52	—1. 57. 45·90
9	A	Make	61	23	0. 49. 19·05	— 2. 24·37	10. 38. 0·00	—1. 57. 43·51
,,	A	Break	62	18	0. 48. 48·98	— 2. 24·37	10. 37. 30·00	—1. 57. 43·50
,,	P	Make	63	24	1. 5. 45·00	— 2. 24·39	10. 54. 25·69	—1. 57. 45·96
,,	P	Break	64	19	1. 5. 45·00	— 2. 24·39	10. 54. 25·60	—1. 57. 45·87
,,	A	Make	65	29	1. 22. 54·84	— 2. 24·40	11. 11. 30·00	—1. 57. 43·26
,,	A	Break	66	25	1. 23. 9·88	— 2. 24·40	11. 11. 45·00	—1. 57. 43·26
Nov. 22, 10	P	Varley's Method	67	17	1. 45. 0·00	— 2. 24·42	11. 33. 35·44	—1. 57. 47·17
,,	A		68	12	2. 21. 5·21	— 2. 24·44	12. 9. 30·00	—1. 57. 42·46
11	P		69	19	2. 45. 0·00	— 2. 24·46	12. 33. 25·47	—1. 57. 47·07
,,	A		70	17	3. 10. 43·56	— 2. 24·48	12. 59. 0·00	—1. 57. 42·28
,,	P		71	18	3. 35. 30·00	— 2. 24·49	13. 23. 47·00	—1. 57. 46·90
12	A		72	13	4. 3. 52·40	— 2. 24·51	13. 52. 0·00	—1. 57. 42·17

In the *make and break* method the circuit was completed and broken at the sending station at intervals of 15 seconds, the operator using alternately the positive and negative key. At the receiving station the first start of the beam of light was the phase of signal observed. The signals referring to completion of the circuit are collected into one group, without distinction of quality, positive or negative; and those referring to break of the circuit into

another group; these groups are indicated in the table above by the words "make" and "break" respectively.

In what is called *Varley's* method the circuit was completed at the sending station for 50 seconds, and broken for 10 seconds, using alternately the positive and negative key. The signals corresponding to break of circuit only were made use of. At the receiving station* the extent of motion of the beam of light, from zero on the scale, having been first noted, a mark was made at the middle point of its excursion. Just before the expected break, the circuit at the sending station will have been closed for nearly 50 seconds, and the beam of light at the receiving station will have come to rest. At this moment the observer shifts the position of the scale so as to bring the beam to the zero point, and, on break of the circuit, notes the time at which the beam transits the provisional mark, which is the phase of signal observed. The groups are formed without any distinction as to quality of current, positive or negative.

The times not fractional indicate means of times of contacts at the sending station, one or two times being occasionally omitted to make the mean identical with the time of some one particular contact, or with a time half way between those of two successive contacts. The fractional times are the means of the observed times of the corresponding signals at the receiving station, noted as described above. Two times are by chance not fractional, $41^{s}\cdot00$ in Group 47, and $47^{s}\cdot00$ in Group 71; they however indicate, as a little consideration would show, means of times of signals received.

We have, in the preceding table, the error of Hewitt 890 (at Alexandria) on Greenwich Mean Solar Time; it is now necessary to find the error of the same chronometer on Mokattam Mean Solar Time.

From the numbers given in Table XVII. (page 314), Errors and Rates of the Mokattam Sidereal Clock, Dent 1914, were adopted as follows:—

Approximate Mokattam Mean Solar Time.		Dent 1914 Slow on Mokattam Sidereal Time (at 0^{h}. Sid. Time).	Adopted Daily Losing Rate.
1874.	h	s	s
November 14,	8	+ 14·00	+ 0·29
15,	8	+ 14·28	+ 0·29
21,	8	+ 17·04	+ 0·62
22,	8	+ 17·78	+ 0·78

These errors and rates are determined entirely from the observations of

* As before mentioned a condenser was placed in the circuit, between the line and the recording instrument, to improve the character of the signal.

Captain Browne, and are employed to infer the errors of Dent 1914, contained in the next table.

TABLE VII.—DETERMINATION of the ERROR of the MEAN SOLAR CHRONOMETER HEWITT 890, at ALEXANDRIA, on MOKATTAM MEAN SOLAR TIME, by exchange of GALVANIC SIGNALS between MOKATTAM and ALEXANDRIA.

Approximate Mokattam Mean Solar Time.	Station giving Signals.	Whether Positive or Negative Signals were given.	No. of Group.	No. of Signals in Group.	At Mokattam. Means of the separate Groups of Signals by Mokattam Sidereal Clock Dent 1914.	At Mokattam. Mokattam Sidereal Clock Slow on Mokattam Sidereal Time.	At Alexandria. Means of the separate Groups of Signals by Chronometer Hewitt 890 (Mean Solar).	At Alexandria. Resulting Error of Hewitt 890 Slow on Mokattam Mean Solar Time.
1874. h					h m s	s	h m s	m s
Nov. 14, 14	M	Positive	73	83	5. 21. 0·00	+ 14·06	13. 38. 22·29	+ 7. 16·43
"	A	Positive	74	77	5. 38. 20·46	+ 14·07	13. 55. 40·00	+ 7. 16·35
"	M	Negative	75	81	5. 59. 40·00	+ 14·07	14. 16. 55·98	+ 7. 16·42
"	A	Negative	76	79	6. 16. 41·72	+ 14·08	14. 33. 55·00	+ 7. 16·34
Nov. 14, 20	M	Positive	77	79	11. 13. 30·00	+ 14·14	19. 29. 54·42	+ 7. 16·63
"	A	Positive	78	73	11. 33. 18·70	+ 14·14	19. 49. 40·00	+ 7. 16·50
"	M	Negative	79	81	11. 50. 50·00	+ 14·14	20. 7. 8·28	+ 7. 16·66
"	A	Negative	80	71	12. 7. 24·31	+ 14·15	20. 23. 40·00	+ 7. 16·54
Nov. 15, 10	M	Positive	81	85	0. 58. 30·00	+ 14·29	9. 12. 38·97	+ 7. 17·06
"	A	Positive	82	77	1. 15. 48·80	+ 14·30	9. 29. 55·00	+ 7. 17·00
"	M	Negative	83	11	1. 26. 10·00	+ 14·30	9. 40. 14·31	+ 7. 17·20
"	A	Negative	84	46	1. 35. 56·93	+ 14·30	9. 50. 0·00	+ 7. 16·84
Nov. 15, 16	M	Positive	85	83	7. 24. 40·00	+ 14·37	15. 37. 45·52	+ 7. 17·34
"	A	Positive	86	69	7. 42. 17·39	+ 14·37	15. 55. 20·00	+ 7. 17·36
"	M	Negative	87	53	7. 55. 20·00	+ 14·38	16. 8. 20·55	+ 7. 17·29
"	A	Negative	88	71	8. 9. 51·88	+ 14·38	16. 22. 50·00	+ 7. 17·34
Nov. 21, 14	M	Positive	89	63	6. 0. 20·00	+ 17·20	13. 50. 3·19	+ 7. 20·84
"	A	Positive	90	40	6. 17. 19·65	+ 17·20	14. 7. 0·00	+ 7. 20·90
"	M	Negative	91	85	6. 32. 30·00	+ 17·21	14. 22. 7·89	+ 7. 20·88
"	A	Negative	92	41	6. 48. 24·74	+ 17·22	14. 38. 0·00	+ 7. 20·91
Nov. 21, 20	M	Positive	93	83	11. 33. 40·00	+ 17·34	19. 22. 28·40	+ 7. 21·15
"	A	Positive	94	73	11. 49. 34·03	+ 17·35	19. 38. 20·00	+ 7. 21·00
"	M	Negative	95	73	12. 7. 0·00	+ 17·35	19. 55. 42·99	+ 7. 21·12
"	A	Negative	96	75	12. 22. 39·46	+ 17·36	20. 11. 20·00	+ 7. 21·02
Nov. 22, 9	M	Positive	97	79	0. 51. 50·00	+ 17·81	8. 38. 27·47	+ 7. 21·79
"	A	Positive	98	73	1. 7. 34·99	+ 17·82	8. 54. 10·00	+ 7. 21·68
"	M	Negative	99	79	1. 23. 30·00	+ 17·83	9. 10. 2·31	+ 7. 21·78
"	A	Negative	100	77	1. 40. 0·34	+ 17·83	9. 26. 30·00	+ 7. 21·73
Nov. 22, 15	M	Positive	101	75	6. 30. 0·00	+ 17·99	14. 15. 41·93	+ 7. 22·11
"	A	Positive	102	61	6. 45. 20·50	+ 18·00	14. 31. 0·00	+ 7. 22·04
"	M	Negative	103	83	7. 0. 50·00	+ 18·01	14. 46. 26·86	+ 7. 22·16
"	A	Negative	104	67	7. 15. 55·49	+ 18·02	15. 1. 30·00	+ 7. 22·04

The observer at the sending station made contacts every 10 seconds; the times not fractional indicate means of times of contacts, a few in each group being usually omitted to make the mean identical with the time of some one particular contact. The fractional times are the means of the observed times of the corresponding signals at the receiving station, as noted on an ordinary upright galvanometer.

TABLE VIII.—MEAN ERRORS on MOKATTAM MEAN SOLAR TIME and RATES of the MEAN SOLAR CHRONOMETER HEWITT 890, at ALEXANDRIA, deduced from the separate determinations of the preceding table.

Time by Chronometer Hewitt 890.		Hewitt 890 Slow on Mokattam Mean Solar Time.	Hourly Losing Rate.
1874.	h m	m s	s
November 14,	14. 6	+ 7. 16·39	+ 0·032
	19. 58	+ 7. 16·58	
November 15,	9. 33	+ 7. 17·02	+ 0·048
	16. 1	+ 7. 17·33	
November 21,	14. 14	+ 7. 20·88	+ 0·034
	19. 47	+ 7. 21·07	
November 22,	9. 2	+ 7. 21·74	+ 0·062
	14. 39	+ 7. 22·09	

TABLE IX.—DEDUCED LONGITUDE of MOKATTAM, EAST of GREENWICH, for each separate group of cable signals, found by combining the DETERMINED ERRORS of the MEAN SOLAR CHRONOMETER HEWITT 890 (at ALEXANDRIA) on GREENWICH and MOKATTAM MEAN SOLAR TIMES.

Approximate Greenwich Mean Solar Time.		By Exchange of Galvanic Signals between Porthcurno and Alexandria.				By Exchange of Galvanic Signals between Mokattam and Alexandria.	Resulting Longitude of Mokattam East of Greenwich.
		No. of Group.	Station giving Signals.	Make or Break Signals, or Varley's Method.	Hewitt 890 Slow of Greenwich Mean Solar Time.	Hewitt 890 Slow of Mokattam Mean Solar Time.	
1874.	h				h m s	m s	h m s
November 14,	14	17	P	Make	− 1. 57. 51·69	+ 7. 16·43	2. 5. 8·12
	,,	18	P	Break	51·64	16·43	8·07
	,,	19	A	Make	48·72	16·44	5·16
	,,	20	A	Break	48·71	16·44	5·15

Approximate Greenwich Mean Solar Time.		By Exchange of Galvanic Signals between Porthcurno and Alexandria.				By Exchange of Galvanic Signals between Mokattam and Alexandria.	Resulting Longitude of Mokattam East of Greenwich.
		No. of Group.	Station giving Signals.	Make or Break Signals, or Varley's Method.	Hewitt 890 Slow of Greenwich Mean Solar Time.	Hewitt 890 Slow of Mokattam Mean Solar Time.	
1874.	h				h m s	m s	h m s
November 14,	14	21	P	Make	— 1. 57. 51·39	+ 7. 16·45	2. 5. 7·84
	„	22	P	Break	51·42	16·45	7·87
	„	23	A	Make	48·55	16·46	5·01
	„	24	A	Break	48·59	16·46	5·05
November 14,	15	25	P	Varley's Method	— 1. 57. 52·58	+ 7. 16·47	2. 5. 9·05
	„	26	A		47·67	16·49	4·16
	16	27	P		52·41	16·51	8·92
	„	28	A		47·54	16·52	4·06
	17	29	P		52·28	16·54	8·82
	„	30	A		47·46	16·54	4·00
November 15,	8	31	P	Make	— 1. 57. 50·87	+ 7. 17·05	2. 5. 7·92
	„	32	P	Break	50·81	17·05	7·86
	9	33	A	Make	48·11	17·07	5·18
	„	34	A	Break	48·27	17·07	5·34
	„	35	P	Make	50·89	17·08	7·97
	„	36	P	Break	50·68	17·08	7·76
	„	37	A	Make	48·13	17·09	5·22
	„	38	A	Break	48·24	17·09	5·33
November 15,	9	39	P	Varley's Method	— 1. 57. 52·15	+ 7. 17·11	2. 5. 9·26
	10	40	A		47·24	17·13	4·37
	„	41	P		52·01	17·15	9·16
	11	42	A		47·02	17·18	4·20
	„	43	P		51·87	17·20	9·07
	12	44	A		46·99	17·22	4·21
November 21,	13	45	P	Make	— 1. 57. 46·91	+ 7. 20·92	2. 5. 7·83
	„	46	P	Break	46·87	20·92	7·79
	14	47	A	Make	44·32	20·93	5·25
	„	48	A	Break	44·39	20·93	5·32
	„	49	P	Make	46·98	20·94	7·92
	„	50	P	Break	46·77	20·94	7·71
	„	51	A	Make	44·33	20·95	5·28
	„	52	A	Break	44·40	20·95	5·35
November 21,	15	53	P	Varley's Method	— 1. 57. 48·35	+ 7. 20·96	2. 5. 9·31
	„	54	A		43·19	20·98	4·17
	16	55	P		48·24	20·99	9·23
	„	56	A		43·15	21·01	4·16
	„	57	P		48·01	21·02	9·03
	17	58	A		43·05	21·04	4·09

Approximate Greenwich Mean Solar Time.		By Exchange of Galvanic Signals between Porthcurno and Alexandria.				By Exchange of Galvanic Signals between Mokattam and Alexandria.	Resulting Longitude of Mokattam East of Greenwich.
		No. of Group.	Station giving Signals.	Make or Break Signals, or Varley's Method.	Hewitt 890 Slow of Greenwich Mean Solar Time.	Hewitt 890 Slow of Mokattam Mean Solar Time.	
1874.	h				h m s	m s	h m s
November 22,	8	59	P	Make	− 1. 57. 45·83	+ 7. 21·82	2. 5. 7·65
	„	60	P	Break	45·90	21·82	7·72
	9	61	A	Make	43·51	21·84	5·35
	„	62	A	Break	43·50	21·84	5·34
	„	63	P	Make	45·96	21·86	7·82
	„	64	P	Break	45·87	21·86	7·73
	„	65	A	Make	43·26	21·87	5·13
	„	66	A	Break	43·26	21·87	5·13
November 22,	10	67	P	Varley's Method	− 1. 57. 47·17	+ 7. 21·90	2. 5. 9·07
	„	68	A		42·46	21·94	4·40
	11	69	P		47·07	21·96	9·03
	„	70	A		42·28	21·99	4·27
	„	71	P		46·90	22·01	8·91
	12	72	A		42·17	22·04	4·21
1		2	3	4	5	6	7

The numbers in column 5 are those found in Table VI., and the numbers in column 6 are inferred from those in Table VIII.

TABLE X.—LONGITUDE of MOKATTAM, EAST of GREENWICH, as separately deduced from the "MAKE" and "BREAK" Cable Signals, in which the first start of the Beam of Light is the Phase observed, and from the "VARLEY METHOD," in which the Time of the Beam arriving at the Middle Point of its Excursion is the Phase observed. (The Signals were given alternately Positive and Negative, and the Groups include usually about an equal number of each kind.)

Day, 1874.	Station giving Cable Signals.	No. of Group.	No. of Signals in Group.	Resulting Longitude.	Station giving Cable Signals.	No. of Group.	No. of Signals in Group.	Resulting Longitude.	Mean for P giving Signals.	Mean for A giving Signals.	Retardation of Current.	Resulting Longitude for each Method on each Day.	No. of Cable Signals.
As deduced from the "Make" Circuit Signals.													
				h m s				h m s	h m s	h m s	s	h m s	
November 14	P	17 21	10 15	2. 5. 8·12 7·84	A	19 23	18 17	2. 5. 5·16 5·01	2. 5. 7·98	2. 5. 5·09	2·89	2. 5. 6·54	60
November 15	P	31 35	18 12	2. 5. 7·92 7·97	A	33 37	17 15	2. 5. 5·18 5·22	2. 5. 7·95	2. 5. 5·20	2·75	2. 5. 6·57	62
November 21	P	45 49	13 21	2. 5. 7·83 7·92	A	47 51	23 22	2. 5. 5·25 5·28	2. 5. 7·87	2. 5. 5·26	2·61	2. 5. 6·57	79
November 22	P	59 63	18 24	2. 5. 7·65 7·82	A	61 65	23 29	2. 5. 5·35 5·13	2. 5. 7·74	2. 5. 5·24	2·50	2. 5. 6·49	94
As deduced from the "Break" Circuit Signals.													
November 14	P	18 22	10 14	2. 5. 8·07 7·87	A	20 24	15 14	2. 5. 5·15 5·05	2. 5. 7·97	2. 5. 5·10	2·87	2. 5. 6·53	53
November 15	P	32 36	12 20	2. 5. 7·86 7·76	A	34 38	18 12	2. 5. 5·34 5·33	2. 5. 7·81	2. 5. 5·34	2·47	2. 5. 6·58	62

TABLE X.—LONGITUDE OF MOKATTAM—*continued.*

Day, 1874.	Station giving Cable Signals.	No. of Group.	No. of Signals in Group.	Resulting Longitude.	Station giving Cable Signals.	No. of Group.	No. of Signals in Group.	Resulting Longitude.	Mean for P giving Signals.	Mean for A giving Signals.	Retardation of Current.	Resulting Longitude for each Method on each Day.	No. of Cable Signals.
				h m s				h m s	h m s	h m s	s	h m s	
November 21	P	46 50	13 17	2. 5. 7·79 7·71	A	48 52	24 21	2. 5. 5·32 5·35	2. 5. 7·75	2. 5. 5·33	2·42	2. 5. 6·54	75
November 22	P	60 64	22 19	2. 5. 7·72 7·73	A	62 66	18 25	2. 5. 5·34 5·13	2. 5. 7·72	2. 5. 5·24	2·48	2. 5. 6·48	84
As deduced from "Varley's" Method.													
November 14	P	25 27 29	14 20 12	2. 5. 9·05 8·92 8·82	A	26 28 30	14 19 10	2. 5. 4·16 4·06 4·00	2. 5. 8·93	2. 5. 4·07	4·86	2. 5. 6·50	89
November 15	P	39 41 43	12 16 20	2. 5. 9·26 9·16 9·07	A	40 42 44	14 19 12	2. 5. 4·37 4·20 4·21	2. 5. 9·16	2. 5. 4·26	4·90	2. 5. 6·71	93
November 21	P	53 55 57	17 14 25	2. 5. 9·31 9·23 9·03	A	54 56 58	19 17 17	2. 5. 4·17 4·16 4·09	2. 5. 9·19	2. 5. 4.14	5·05	2. 5. 6·67	109
November 22	P	67 69 71	17 19 18	2. 5. 9·07 9·03 8·91	A	68 70 72	12 17 13	2. 5. 4·40 4·27 4·21	2. 5. 9·00	2. 5. 4·29	4·71	2. 5. 6·64	96

TABLE XI.—COLLECTION of RESULTS for each METHOD of CABLE SIGNALLING, and APPARENT LONGITUDE.

Day, 1874.	Resulting Longitude given by the								Apparent Longitude.	Total No. of Cable Signals.
	Make of Circuit.	No. of Cable Signals.	Break of Circuit.	No. of Cable Signals.	Mean of Make and Break.	No. of Cable Signals.	Varley Method.	No. of Cable Signals.		
	h m s		h m s		h m s		h m s		h m s	
November 14	2. 5. 6·54	60	2. 5. 6·53	53	2. 5. 6·54	113	2. 5. 6·50	89	2. 5. 6·52	202
15	6·57	62	6·58	62	6·57	124	6·71	93	6·64	217
21	6·57	79	6·54	75	6·56	154	6·67	109	6·62	263
22	6·49	94	6·48	84	6·48	178	6·64	96	6·56	274
Means	2. 5. 6·54	295	2. 5. 6·53	274	2. 5. 6·54	569	2. 5. 6·63	387	2. 5. 6·58	956

The apparent longitude $2^h. 5^m. 6^s\cdot58$ depends on transits observed at Greenwich by Mr. Criswick, and at Mokattam by Capt. Browne, and requires also correction for personal equation in the methods of giving and receiving signals.

TABLE XII.—COLLECTION of RESULTS for RETARDATION of the GALVANIC CURRENT in the SUBMARINE CABLE.

Day 1874.		Cable Retardation given by the					
		Make of Circuit.	No. of Cable Signals.	Break of Circuit.	No. of Cable Signals.	Varley Method.	No. of Cable Signals.
		s		s		s	
November	14	2·89	60	2·87	53	4·86	89
	15	2·75	62	2·47	62	4·90	93
	21	2·61	79	2·42	75	5·05	109
	22	2·50	94	2·48	84	4·71	96
Means		2·69	295	2·56	274	4·88	387

These values apply to the retardation in the cable portion of the line only; the land retardation and the effect of personal equation in the land signalling, both in England and Egypt, being eliminated by the method of reduction employed. But they are affected by Mr. Ellis's manner of giving and receiving cable signals at Porthcurno, and by Mr. Hunter's manner of giving and receiving cable signals at Alexandria; and these influences cannot be separated. The error thereby introduced into the retardation (judging by the numbers given on pages 285 and 286) is presumably small.

The mean of the results from the "make" and "break" methods gives $2^s{\cdot}62$ for the sum of the cable retardations in both directions, or $1^s{\cdot}31$ for the retardation between Porthcurno and Alexandria, or between Alexandria and Porthcurno.*

The value $4^s{\cdot}88$ includes the sum of the cable retardations in both directions + the time occupied by the beam at both stations (Porthcurno and Alexandria) in reaching the middle point of its excursion.

CORRECTION of the GREENWICH-MOKATTAM LONGITUDE for the effects of PERSONAL EQUATION.

The Greenwich-Mokattam longitude requires correction for the personal equations between the observers who gave and received signals, and for the difference of the manner in which the observers at Greenwich and Mokattam

* Mr. Varley had estimated the retardation each way at $1\frac{1}{4}^s$.

determined clock-error. After the return of Captain Browne from Egypt the necessary comparisons for determination of these various differences among the observers who took part in the longitude work were made.

To ascertain the personal differences in giving signals, the Greenwich Chronograph was employed. Any two observers to be compared made contacts alternately with a key such as was used in the actual longitude work. The corresponding signals were registered on the Chronograph, the times of contact being so symmetrically arranged that the means of all the times referred for each observer to the same moment of absolute time. Several sets of observations were made, the observers being interchanged in various ways.

For the personal differences in receiving signals, a galvanometer, such as was used in the longitude work, being mounted in a convenient position, an assistant, placed in a different apartment, gave signals, which the various observers noted, using the same clock. Several different sets of observations were made.

A discussion of the whole of the comparisons made gave the following results, the initials E, C, B, and H referring respectively to Mr. Ellis, Mr. Criswick, Captain Browne, and Mr. Hunter. C is taken as the standard of reference :—

	Resulting difference In giving signals.	Resulting difference In receiving signals.
	s	s
C — E,	+ 0·068	— 0·090
C — B,	+ 0·033	— 0·105
C — H,	+ 0·038	— 0·043

Thus E makes contact $0^s{\cdot}068$ earlier than C, but notes a signal $0^s{\cdot}090$ later than C. These numbers refer to the giving and receiving of signals on the land lines, and to giving on the submarine line, but not to receiving on the submarine line.

In receiving longitude-signals on the cable the comparatively slow motion of a beam of light was observed in two different ways. In one the first start of the beam was observed, in the other the time of transit of the beam over a provisional mark was observed. Some trials of the latter method made in the month of August 1874, in the first instance with Mr. C. F. Varley's artificial cable (kindly lent by him for experiment), and afterwards at Porthcurno on

the Eastern Telegraph Company's submarine cable, gave differences as follows :—

	Difference in receiving signals. E – H.
	s
At Royal Observatory, Greenwich, by use of Varley's artificial cable—	
1874, August 13 and 15 (direct comparison)	0·00
,, 15 and 18 (compared through B)..................	+ 0·14
At Porthcurno, on the Eastern Telegraph Company's submarine cable—	
1874, August 30 (compared through B)	0·00
,, 30 (direct comparison)	– 0·12

No comparisons of the method of observing the first start of the beam were made, as the use of this method was not proposed until the Egyptian Expedition was about to leave England.

Now, as regards the actual corrections to be applied—

Mr. Criswick observed transits at Greenwich (or the transits of other observers were reduced to his method), and exchanged signals on the English land line with Mr. Ellis at Porthcurno.

Mr. Ellis at Porthcurno exchanged signals on the English land line with Mr. Criswick at Greenwich, and on the submarine line with Mr. Hunter at Alexandria.

Mr. Hunter at Alexandria exchanged signals on the Egyptian land line with Captain Browne at Mokattam, and on the submarine line with Mr. Ellis at Porthcurno.*

Captain Browne observed transits at Mokattam, and exchanged signals on the Egyptian land line with Mr. Hunter at Alexandria.

The manner of giving signals was similar both in the land and cable work. The personal equations of E and H thus disappear in the deduced longitude, and C and B may be supposed to have been in direct connexion. By what has preceded it will be seen that B makes contact in giving signals $0^{s}\cdot033$ earlier than C, the effect of which is to increase the east longitude of Mokattam by the half of this quantity, because each operator gave signals in one half only of the whole number of groups. Or the apparent longitude requires a correction of $-0^{s}\cdot016$.

As regards the receipt of signals, it is to be remarked that E and H both used, on the one hand a land line, and on the other hand a submarine line.

* Mr. Hunter also observed transits at Alexandria for determination of the longitude of Alexandria, but this does not come into consideration here.

The signal received on the latter, as has been mentioned, is of a character different to that received on the former; it is therefore necessary to consider separately each section of the work. In the first section C at Greenwich exchanged signals with E at Porthcurno, using a land line. E receives land signals $0^s{\cdot}090$ later than C. The correction required by the longitude on this account will be $-0^s{\cdot}045$. In the second section E at Porthcurno exchanged signals with H at Alexandria, using the submarine line. There is a little uncertainty as concerns the difference between E and H in receiving cable signals, but according to the comparisons given on page 286 it would appear that the difference in the method of observing the Varley signal was probably small. It will perhaps not be far from the truth to conclude that for both methods of cable receiving there was no practical difference. On this assumption no correction is required on account of receiving signals in the second section. In the third section H at Alexandria exchanged signals with B at Mokattam, using a land line. Now B receives land signals $0^s{\cdot}105$ later than C, and H $0^s{\cdot}043$ later than C, or B receives later than H by $0^s{\cdot}062$. Consequently the correction required by the longitude will be $-0^s{\cdot}031$. Or the total correction to be applied on account of personal equation in receiving signals is $-0^s{\cdot}076$.

The correction for personal equation between C and B in the manner of observing transits has now to be considered.

The transit instrument which was subsequently used at Mokattam was mounted upon a pier of masonry in the south ground of the Royal Observatory at Greenwich, and was used by Captain Browne to determine the error of the Sidereal Clock *Dent* 1914. The instrument was 185 feet east of the meridian of the Transit-Circle. During the observations each day, the clock *Dent* 1914 was several times compared with the Sidereal Chronometer, sympathetic with the Sidereal Standard Clock and Chronograph, by the intervention of a mean time half-seconds chronometer. Captain Browne made observations of this character on three nights before he went to Egypt, and on four nights after his return. It is not considered necessary to give the details of these observations, which were of the same character and quality as those made at Mokattam.

Making a correction of $0^s{\cdot}195$ for the difference of longitude between the two instruments, the results obtained were that Captain Browne (using the small transit, and observing by eye and ear) made the Sidereal Standard

"clock slow" greater than that of the Greenwich standard observer (using the Greenwich Transit Circle and Chronograph), as follows :—

		s
1874, August 15,	B − C = +	0·195
21,		0·139
September 4,		0·405
1875, July 6,		0·655
28,		0·195
31,		0·155
August 23,		0·025
Mean		+ 0·253

There appears to be no reason for rejecting the discordant result of July 6. The observations on that night with both instruments were as numerous and apparently as good as those on any other night.

We are now in a position to form the Concluded Longitude of Mokattam :—

	h m s
Apparent Longitude of Mokattam East of Greenwich, as deduced from Table XI.	2. 5. 6·58
Correction for personal equation between the Observers—	
In giving signals, $-0^s\cdot016$; In receiving signals, $-0^s\cdot076$	− 0·09
Correction for personal equation between C and B in the manner of obtaining star transits	− 0·25
CONCLUDED LONGITUDE OF MOKATTAM, EAST OF GREENWICH	2. 5. 6·24

W. E.
C. O. B.

OBSERVATIONS OF THE EGRESS OF VENUS, 1874, DECEMBER 8, AT MOKATTAM, NEAR CAIRO.

Report of Captain C. Orde Browne.

For practice in observation of the actual phenomena, as far as possible, a working model had been brought out, similar to that previously used at Greenwich (Plate V.). Mr. Hunter was in this respect at a disadvantage, having his time much taken up by his preparations at Suez. He found time, however, to practice a little on the model at Mokattam.

At Mokattam the work of preparation consisted in the trial and the improvement of the working of the observing instruments, in the model practice, and rehearsals of the operations at sunrise.

The De la Rue Equatorial had taken the place of the Altazimuth, and with its clock and movable dome was in admirable working order.

Convenient observing seats and other arrangements, in accordance with the directions issued by the Astronomer Royal, had been made.

Mahmoud Bey, the Director of the Egyptian Government Observatory at Abbasseyah, had repeatedly visited the Mokattam Station, and had watched the phenomena of contact on the model; and it may here be noticed that Dr. Auwers and M. Döllen, who visited the station at Mokattam, had expressed their concurrence as to the phase of formation of the black drop, if any were seen, which ought specially to be observed at Egress, namely, the instant when the connexion which was forming assumed the same blackness as the body of the planet.

During the first week in December there was much mist in the plain of Cairo, and on the three mornings preceding the day of the transit the Sun had been wholly invisible at Mokattam, except for about 20 minutes on one occasion.

About sunset on December 8, by order of the Khedive, a considerable body of cavalry trotted up to the camp and picketed for the night. Infantry and police subsequently arrived, and were posted on the following morning so as to form a cordon round the station to prevent the approach of strangers. During the night I obtained transits of stars through openings in the clouds.

The wind continued in the S.W., and as the day began to dawn it was evident that the sky was clearing from that quarter.

I set the two observing clocks, Dent 2009 and 2015, as nearly as possible to true sidereal time, and then compared them with the transit-clock.

The "Lee Equatorial," with which I observed the Egress of *Venus*, was the famous instrument by TULLEY, used by the late Admiral SMYTH, and fully described by him in the first column of his *Cycle of Celestial Objects*. It was purchased by the Government expressly for the Transit of Venus. At Mokattam the polar axis was supported by massive structures of timber, which rested upon the solid rock, but otherwise the instrument, accessories, mounting, and driving-clock were in every respect the same as formerly, but perhaps, rather the worse for wear. The hour-circle, which was also the driving-circle, had been seriously distorted by a fall, and could not be perfectly restored, but it answered its purpose well. The instrument was protected by a large portable wooden hut constructed at Greenwich.

The tube of the telescope had been shortened a little to admit of the use of a new solar diagonal reflector. Slow motion in Right Ascension to a limited extent was effected by the slipping piece, described by Admiral SMYTH, which carried the eye-piece at times out of the true centering. For the proper equalisation of the illumination of the images of the double-image micrometer eye-piece it was imperative to have the latter fairly centered, which was effected by trial, an assistant manipulating the driving-clock.

The double-image micrometer and solar reflector are represented in Plate III. The power used was 158. The internal contact was observed with a negative eye-piece of 212,* constructed to correct atmospheric dispersion by tilting the eye-lens, but the definition being very good the eye-lens was not disturbed.

The Sun rose behind a bank of cloud; indeed, the sky was quite thick towards the north and east horizon, but clear from the south-west up to the zenith, and the clouds were breaking still further in the desired direction. As the Sun rose higher the clouds became more broken. The intervals of obscurity, however, were long and trying, especially the last, which began eight minutes before internal contact, and lasted about five minutes.

As opportunity occured, I obtained the following measurements with the micrometer for the diameter of the planet, and the distance between its approaching limb and the limb of the Sun. Sometimes the images were distorted by atmospheric tremor; at others the definition was excellent. I

* Not 150, as stated in the *Parliamentary Report*, page 16.

was struck by the exact resemblance to model practice. Some of the measures were obtained without the intervention of the darkening wedge, but it was generally required. My wife called aloud the seconds from the Sidereal Clock Dent 2009, and recorded the observations :—

MICROMETER READINGS for the DOUBLE DIAMETER of VENUS.

rev.	rev.
17·049	26·841
17·165	26·850
17·159	26·842
17·141	26·780
17·161	26·793
26·755	17·135
26·799	

The zero, or reading for coincidence of images, was approximately $22^{r}\cdot0$. The smaller readings are in a negative, the larger in a positive, direction from zero.

MICROMETER READINGS for the DISTANCE between the NEAR LIMBS of the SUN and VENUS, along the Line of Centers.

Time by Dent 2009.	Micrometer Readings.	Time by Dent 2009.	Micrometer Readings.
h m s	rev.	h m s	rev.
12. 37. 39	16·350	13. 0. 24	18·922
38. 51	16·440	0. 38	18·960
40. 8	16·712	1. 18	19·140
40. 21	16·619	5. 48	19·655
40. 42	16·667		
45. 12	17·241	7. 56	24·351
46. 9	17·391	9. 14	24·168
47. 10	17·531	9. 31	24·104
47. 52	17·480	10. 6	24·028
48. 8	17·550	10. 25	23·912
53. 48	18·250*	10. 41	23·874
54. 19	18·231	10. 59	23·860
55. 45	18·436	11. 48	23·693
56. 8	18·506	12. 3	23·611
56. 39	18·589	12. 35	23·437
57. 14	18·591	12. 52	23·544
58. 55	18·845	13. 22	23·491
59. 31	18·891	14. 10	23·402
12. 59. 53	18·834	13. 14. 34	23·343

* Bad.

The last cloud remained so long that I was afraid to leave the micrometer in the telescope any longer, so I changed it for the negative eye-piece (212). When the cloud opened I saw *Venus* very close to the limb, but no sort of shadow of contact as yet. The shadow then began to appear, and I tried to note the instant, but feared to interrupt my wife counting so near contact. I tried to note some one instant, but could not, the shadow came so gradually. The Sun becoming brighter, I saw a modified short ligament form, but did not see the edges form into sharp curves and creep apart, as sometimes with the model. Blackness gathered gradually, and at last came an instant when it seemed to be as black as the planet, and to have no light crossing it. This was at 13^h. 22^m. 25^s. by the clock. As I continued to watch the ligament (not moving my eye from the telescope), the Sun became suddenly brighter, and I saw a sort of parting of the ligament by a very narrow white line, which either became definite, or I perceived it to be definite, as the egress went on. This appearance is represented in Figure 1, Plate X., but I cannot draw the white line fine enough. The white line clung to the planet's edge, and at last the planet was projecting beyond the Sun's limb, with the thread of light clearly biting into the sky. (Figure 2, Plate X.)

I account for having seen the internal contact apparently completed by the fact that there yet remained a film of cloud over the Sun, of which I was made aware by the Sun becoming brighter just as the line appeared. I watched this appearance until 13^h. 24^m. 25^s. by the clock, when I concluded that the white line was not of a passing character, but was due to atmosphere or some other cause. Feeling disappointed at having, in consequence, lost two of the most valuable minutes, I replaced the micrometer and took the following measures of the distance between the cusps and of the diameter of Venus, in the direction parallel to the line of cusps, the latter being continued until the planet was half emerged :—

MICROMETER READINGS for DISTANCE of CUSPS.

Time by Dent 2009.	Micrometer Readings.	Time by Dent 2009.	Micrometer Readings.
h m s	rev.	h m s	rev.
13. 25. 59	25·249	13. 27. 53	25·930
26. 26	25·451	28. 18	26·021
26. 50	25·439	28. 44	26·104
27. 10	25·630	29. 5	26·145
27. 35	25·802	29. 23	26·258

MICROMETER READINGS for the DOUBLE DIAMETER of VENUS.

rev.	rev.
26·971	16·993
26·966	17·075 bad.
26·998	17·013
26·995	17·065
26·987	17·081
———	17·005
16·927	17·068

The EXTERNAL CONTACT, as far as I could judge, took place at $13^{h}. 50^{m}. 33^{s}$. The clocks were then again compared with the transit.

The transit being over, the three telescopes were placed so as to observe the model simultaneously. The management of the mirror for illuminating the model required considerable delicacy, so that Mr. Newton and I had to manipulate it alternately. Our comparison was therefore made through Miss Newton. Ten comparisons were made in each case; at the conclusion of which it was found that Mr. Newton recorded contact $2^{s}·5$, and Miss Newton $0^{s}·8$, later than I did.

If these corrections be applied to our recorded times of the actual internal contact the latter would all be brought within the same second of time. The application of such a correction, however, is a matter affecting other stations, and cannot be done here.

Speaking generally of the contact as seen at Mokattam it may be noticed, by reference to the individual accounts, that in every case the gradual formation of a *black drop* was perceived a little before contact, a shadow being first seen between *Venus* and the Sun's limb, which deepened gradually until a blackness nearly, if not quite, as dark as the body of the planet seemed to flow over it. This was the instant noted as contact. Almost directly after this each observer was perplexed by detecting light crossing the ligament, which quickly became definite, till it shone out as a sharply defined silver thread, which made any estimate of *geometrical* contact impossible.

C. ORDE BROWNE.

COMPARISONS of the EQUATORIAL SIDEREAL CLOCK DENT 2009 with the TRANSIT CLOCK by the intervention of the SOLAR CHRONOMETER FRODSHAM $\frac{3}{3308}$, and inferred ERRORS and RATE of No. 2009.

1874.	Time by Transit Clock at Comparison.	Chronometer Time of comparison with		Time by Clock No. 2009 at Comparison.	No. 2009 slow on Sidereal Time.	No. 2009 Hourly Rate.
		Transit Clock.	No. 2009.			
	h m s	h m s	h m s	h m s	s	s
Dec. 8	9. 53. 36·0	4. 42. 50·0	4. 53. 5·0	10. 4. 21·0	− 0·54	
	9. 56. 40·0	4. 45. 53·5	4. 56. 3·5	10. 7. 20·0	− 0·55	
	14. 15. 12·0	9. 3. 43·0	8. 44. 19·5	13. 56. 14·0	− 0·82	− 0·08
	14. 18. 15·0	9. 6. 45·5	8. 47. 20·0	13. 59. 15·0	− 0·83	
	14. 21. 17·0	9. 9. 47·0	8. 50. 25·5	14. 2. 21·0	− 0·82	

COMPARISONS of the SIDEREAL CLOCK DENT 2015 with the TRANSIT CLOCK by the intervention of the SOLAR CHRONOMETER FRODSHAM $\frac{3}{3308}$, and inferred ERRORS and RATE of No. 2015.

1874.	Time by Transit Clock at Comparison.	Chronometer Time of comparison with		Time by Clock No. 2015 at Comparison.	No. 2015 slow on Sidereal Time.	No. 2015 Hourly Rate.
		Transit Clock.	No. 2015.			
	h m s	h m s	h m s	h m s	s	s
Dec. 8	9. 53. 36·0	4. 42. 50·0	5. 12. 26·0	10. 23. 45·0	− 0·34	
	9. 56. 40·0	4. 45. 53·5	5. 15. 34·5	10. 26. 54·0	− 0·33	+ 0·16
	14. 15. 12·0	9. 3. 43·0	8. 56. 42·5	14. 8. 38·0	+ 0·22	
	14. 18. 15·0	9. 6. 45·5	8. 59. 34·0	14. 11. 30·0	+ 0·19	

OBSERVATION of the EGRESS of VENUS, 1874, December 8, by Mr. F. M. NEWTON.

Mr. Newton was indebted to the kindness of Mr. WARREN DE LA RUE for the use of a fine Equatorial by Dallmeyer of 4½ inches aperture, driven by clockwork, and fitted with a solar diagonal reflecting prism. This instrument was mounted in the hut with revolving roof sent from England for the Altazimuth. The Secondary Sidereal Clock *Dent* 2015 was also mounted within the hut, and was used by Mr. Newton; its comparisons with the transit-clock are given on the preceding page.

For the observation of the Internal contact, Miss Newton used an achromatic of 3 inches aperture, the property of her brother, temporarily mounted on a rough equatorial stand, constructed of wood. The Sun was viewed directly, that is, without the intervention of a reflector.

Mr. Newton writes to the Astronomer Royal from Mokattam Heights, 1874, December 7 :—

"I take the liberty of sending you a drawing of *Venus* [Plate X., Fig. 6] taken with Mr. De la Rue's exquisite telescope on Saturday, 5th, at 1^h, showing that the crescent is now considerably more than a semicircle.* . . . . . I thought it would be well to note, before the transit occurs, an appearance which seems to point to an atmosphere on *Venus*, which may make the phænomena of the *black drop* in the real transit rather different from those in the Model transit. The power used in making the drawing was 300 diameters."

"*Account of Impressions during the Egress of Venus*, 1874, *December* 8.

"The clouds broke at $12^h.\ 9^m.\ 4^s$. I was using a reflecting solar eye-piece with power 145, and saw *Venus* at intervals. Finding the clouds continuous, I put in an eye-piece magnifying only 52 diameters, and after observing with it a few minutes, I removed the dark glass and observed the image projected on a sheet of paper, in which the diameter of *Venus* was about ⅝ths of an inch. I thought that very good observations could be made in this manner.†

"The weather improving I replaced the eye-piece of 145. Light clouds obscured the Sun at intervals, and the limb was "boiling" considerably. About 10 minutes before contact a thick cloud swept over the Sun, completely obscuring it. This, happily, cleared off about 10 seconds before contact, leaving the Sun fairly but not well defined, owing to a slight haze following the cloud. The contact was observed through this at $13^h.\ 22^m.\ 20^s\cdot7$ by the

* In Mr. Newton's original sketch the bright cusps are 143° apart; in other words, the crescent is 37° more than a semicircle.

† This method was employed by the members of the Mexican Expedition to Japan.

Sidereal Clock. Very little ligament. Having written down the seconds I looked at the clock for the minutes.

"On returning to the telescope I at once observed a thin line of light surrounding Venus' limb at that part where contact had just taken place. My first idea was that contact had not really occurred, but I almost immediately saw the line of light projecting beyond the Sun distinctly into the sky. (Figure 3, Plate X.) This appearance was permanent as long as I kept my eye to the telescope—some 80 to 100 seconds. I then removed the eye-piece of 145, and replaced it with one of 52 diameters, with which I continued to observe *Venus* until external contact.

	h m s
"Estimated passage of Venus' center at	13. 36. 30
"Last External contact	13. 51. 0

"My sister was present during the last observation, and observed it with me.

"F. M. NEWTON."

MISS NEWTON writes :—

"I noted Internal contact at 8^h. 10^m. 35^s. by Frodsham's Chronometer. Appearance much the same as in the Model, but the ligament less sharply defined. (Fig. 4, Plate X.) In a few seconds the ligament began to grow paler, and at 11^m. 30^s. seemed almost to disappear (Fig. 5, Plate X.), so that I thought I must have been mistaken in my first observation of contact. *Venus* appeared to touch the limb of the Sun *without* any ligament at 12^m. 0^s.

"At 8^h. 20^m. 50^s. the planet's disc began to assume the black drop appearance. At 26^m. 30^s. it appeared as a semicircle.

"I observed external contact by means of the image projected by Mr. De la Rue's telescope at 13^h. 50^m. 50^s. by the clock *Dent* 2015.

"E. M. NEWTON."

The comparisons of the Solar Chronometer *Frodsham* $\frac{3}{3308}$* with the transit clock given on page 294 yield the following errors of the chronometer :—

	Local Mean Time.	Frod. $\frac{3}{3308}$ Slow on L. M. T.	Hourly Losing Rate.
	h m	s	s
1874, December 8,	16. 43	+ 31.91	
	16. 46	+ 31.91	+ 0·05
	21. 4	+ 32. 13	
	21. 7	+ 32. 14	

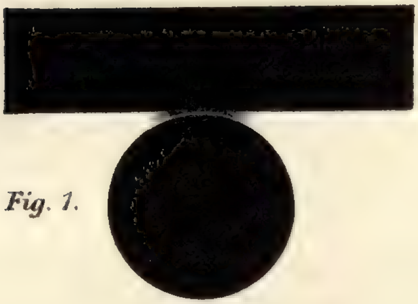
* In the *Parliamentary Report* this number of the chronometer was erroneously given as 1752.

Plate X

Transit of Venus 1874 Dec. 8.

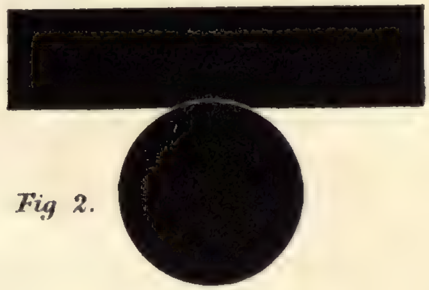
Diagrams relating to the Egress of Venus as observed at Mokattam.

Fig. 1.



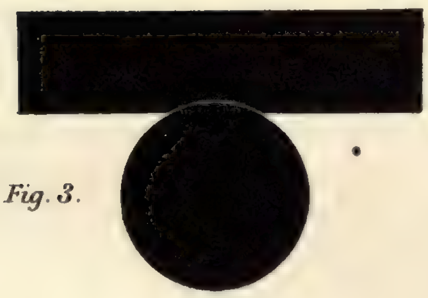
Capt. Browne.

Fig 2.



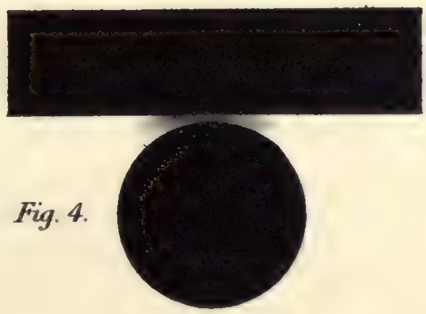
Capt. Browne.

Fig. 3.



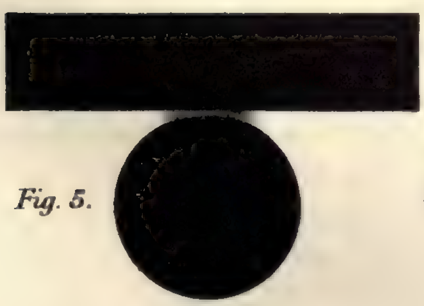
Mr Newton

Fig. 4.



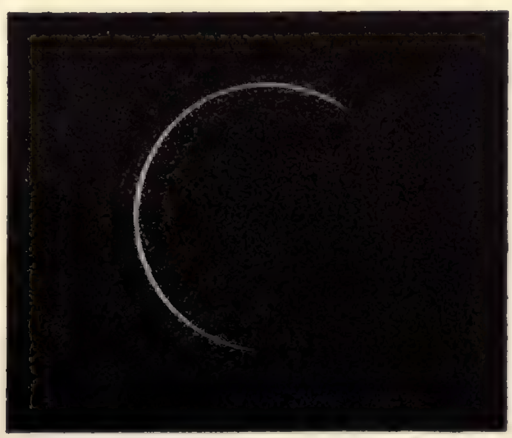
Miss Newton.

Fig. 5.



Miss Newton.

Fig. 6.



Mr Newton.

Dangerfield. Lith. 22 Bedford St Covent Garden

EQUATIONS RESULTING FROM THE MICROMETRICAL OBSERVATIONS AT MOKATTAM.

From the first series of Captain Browne's micrometric measures of the double diameter of the planet are obtained the quantities—

	rev.
Diameter of *Venus*	4·837
Zero-reading	21·972

From the final series are obtained—

	r
Diameter of *Venus*	4·977
Zero-reading	22·005

The mean of the two determinations of the diameter, which are not in very close agreement, is $4^{r}\cdot907$, and taking the tabular diameter as $62''\cdot84$, the value of one revolution of the micrometer-screw is—

$$12''\cdot806 + 0\cdot408\ \delta r,$$

where δr is the correction required to the tabular semidiameter, to be determined hereafter.

It is essential in using the double-image micrometer of this construction that the zero, or reading corresponding to the coincidence of the images, be determined with the micrometer-screw in the same *position angle*, with regard to its rotation around the axis of the micrometer itself, as it had during the measures. There are no means of knowing the position of the screw during the first series of measures of double diameters, hence the zero-reading obtained from them should not be employed.

The Zero proper to the measures of the distance of *limbs* is obtained by comparing the measures themselves, before and after the change from the negative to the positive side, with the computed tabular quantities. In this way, using the five readings on each side of zero, between $12^{h}.\ 59^{m}.\ 53^{s}.$ and $13^{h}.\ 10^{m}.\ 25^{s}.$, the zero $22^{r}\cdot152$ is obtained, and has been applied to all the measures in order to obtain the observed distance of limbs in terms of the revolution of the screw. This has been converted into arc by using the value of one revolution given above.

For the *Cusp* measures the zero proper to employ is that obtained from the final series of double-diameter measures, viz., $22^{rev}\cdot005$, the micrometer not having been rotated in the interim. It will be seen that the last five or six cusp measures are entitled to but little weight, they having been observed more than five minutes after contact.

The Equations are then formed in the manner described in the Honolulu section, page 47, adopting the same notation and taking the tabular semidiameter of the Sun 16′. 16″·82. The mean of the 23 measures on the negative side had been considered equal in weight to the mean of the 14 measures on the positive side, by which the zero is eliminated.

For the *Telescopic Contact* at Egress, assuming the Latitude 30°. 1′. 46″·4 N., Longitude $2^h. 5^m. 6^s·58$ East of Greenwich, we have:—

Observer.	Recorded Clock Time.	Mokattam Sidereal Time.	Greenwich Sidereal Time.	Local Tabular Distance of Centers of the Sun and Venus.
INTERNAL CONTACT.				
	h m s	h m s	h m s	′ ″
F. M. Newton	13. 22. 20·7	13. 22. 20·90	11. 17. 14·32	15. 41·34
E. M. Newton	8. 10. 35·	13. 22. 23·22	11. 17. 16·64	15. 41·42
Browne	13. 22. 25·	13. 22. 24·35	11. 17. 17·77	15. 41·45
E. M. Newton	8. 12. 0·	13. 23. 48·45	11. 18. 41·87	15. 44·31
EXTERNAL CONTACT.				
Browne	13. 50. 33·	13. 50. 32·32	11. 45. 25·74	16. 43·90
E. M. Newton	13. 50. 50·	13. 50. 50·30	11. 45. 43·72	16. 44·64
F. M. Newton	13. 51. 0·	13. 51. 0·30	11. 45. 53·72	16. 45·03

EQUATIONS resulting from the MICROMETRIC OBSERVATIONS of the DISTANCE of LIMBS at MOKATTAM, near CAIRO, Latitude, 30°. 1′. 46″·4 N., Adopted Longitude, $2^h. 5^m. 6^s·58$ East of Greenwich.

Number.	Recorded Clock Time.	Corresponding Greenwich Sidereal Time.	Tabular Apparent Distance of Centers.	Recorded Micrometer Reading.	Observed Distance of Limbs.	Resulting Equations for Distance of Centers of the Sun and Venus, assuming R = 976″·82, r = 31″·42, and Mean Solar Parallax = 8″·950 $(1 + \frac{n}{100})$.						
	h m s	h m s	′ ″	r	″	″				″		
1	12. 37. 39·0	10. 32. 31·8	14. 25·66	16·350	74·31 + 2·366 δr	0 = 5·43	+ 0·1618 n	+ 0·0736 δ R.A.	+ 0·9968 δ N.P.D.	− 0·0223 δt	+ δ R	− 3·366 δr
2	12. 38. 51·0	10. 33. 43·8	14. 27·28	16·440	73·15 + 2·329	4·97	·1633	·0785	·9964	·0226		3·329
3	12. 40. 8·0	10. 35. 0·8	14. 29·00	16·612	70·95 + 2·260	5·45	·1647	·0838	·9959	·0229		3·260
4	12. 40. 21·0	10. 35. 13·8	14. 29·32	16·619	70·86 + 2·256	5·22	·1648	·0847	·9958	·0230		3·256
5	12. 40. 42·0	10. 35. 34·8	14. 29·78	16·667	70·24 + 2·239	5·38	·1653	·0861	·9956	·0231		3·239
6	12. 45. 12·0	10. 40. 4·8	14. 36·15	17·241	62·89 + 2·003	6·36	·1700	·1045	·9935	·0244		3·003
7	12. 46. 9·0	10. 41. 1·8	14. 37·53	17·391	60·97 + 1·942	6·90	·1712	·1083	·9931	·0247		2·942
8	12. 47. 10·0	10. 42. 2·8	14. 39·04	17·531	59·18 + 1·885	7·18	·1722	·1124	·9925	·0250		2·885
9	12. 47. 52·0	10. 42. 44·8	14. 40·07	17·480	59·83 + 1·905	5·50	·1728	·1153	·9921	·0252		2·905
10	12. 48. 8·0	10. 43. 0·8	14. 40·47	17·550	58·93 + 1·876	6·00	·1732	·1163	·9920	·0253		2·876
11	12. 53. 48·0	10. 48. 40·8	14. 49·28	18·250	49·97 + 1·591	6·15	·1787	·1387	·9886	·0268		2·591
12	12. 54. 19·0	10. 49. 11·8	14. 50·10	18·231	50·21 + 1·599	5·09	·1792	·1407	·9883	·0269		2·599
13	12. 55. 45·0	10. 50. 37·8	14. 52·42	18·436	47·59 + 1·517	5·39	·1807	·1463	·9874	·0273		2·517
14	12. 56. 8·0	10. 51. 0·8	14. 53·05	18·506	46·69 + 1·489	5·66	·1809	·1478	·9871	·0274		2·489
15	12. 56. 39·0	10. 51. 31·8	14. 53·89	18·589	45·63 + 1·452	5·88	·1816	·1498	·9867	·0276		2·452
16	12. 57. 14·0	10. 52. 6·8	14. 54·89	18·591	45·60 + 1·452	4·91	·1821	·1521	·9863	·0277		2·452
17	12. 58. 55·0	10. 53. 47·8	14. 57·69	18·845	42·35 + 1·350	5·36	·1834	·1585	·9851	·0281		2·350
18	12. 59. 31·0	10. 54. 23·8	14. 58·68	18·891	41·76 + 1·330	4·96	·1841	·1608	·9847	·0283		2·330
19	12. 59. 53·0	10. 54. 45·8	14. 59·30	18·834	42·49 + 1·354	3·61	·1844	·1622	·9844	·0284		2·354
20	13. 0. 24·0	10. 55. 16·8	15. 0·18	18·922	41·37 + 1·317	3·85	·1848	·1642	·9840	·0285		2·317
21	13. 0. 38·0	10. 55. 30·8	15. 0·58	18·960	40·88 + 1·301	3·94	·1851	·1651	·9838	·0286		2·301
22	13. 1. 18·0	10. 56. 10·8	15. 1·72	19·140	38·57 + 1·228	5·11	·1856	·1676	·9834	·0289		2·228
23	13. 5. 48·0	11. 0. 40·8	15. 9·62	19·655	31·98 + 1·020 δr	0 = 3·80	+ 0·1895 n	+ 0·1845 δ R.A.	+ 0·9798 δ N.P.D.	− 0·0302 δt	+ δ R	− 2·020 δr
24	13. 7. 56·0	11. 2. 48·8	15. 13·48	24·351	28·15 + 0·898 δr	0 = 3·77	+ 0·1912 n	+ 0·1923 δ R.A.	+ 0·9780 δ N.P.D.	− 0·0306 δt	+ δ R	− 1·898 δr
25	13. 9. 14·0	11. 4. 6·8	15. 15·86	24·168	25·81 + 0·825	3·73	·1921	·1971	·9769	·0310		1·825
26	13. 9. 31·0	11. 4. 23·8	15. 16·39	24·104	24·99 + 0·796	4·02	·1923	·1981	·9767	·0310		1·796
27	13. 10. 6·0	11. 4. 58·8	15. 17·46	24·028	24·02 + 0·767	3·92	·1929	·2002	·9762	·0312		1·767
28	13. 10. 25·0	11. 5. 17·8	15. 18·04	23·912	22·53 + 0·719	4·83	·1931	·2014	·9759	·0313		1·719
29	13. 10. 41·0	11. 5. 33·8	15. 18·56	23·874	22·05 + 0·702	4·79	·1932	·2024	·9756	·0314		1·702
30	13. 10. 59·0	11. 5. 51·8	15. 19·11	23·860	21·87 + 0·698	4·42	·1935	·2034	·9754	·0314		1·698
31	13. 11. 48·0	11. 6. 40·8	15. 20·64	23·693	19·73 + 0·629	5·03	·1941	·2064	·9747	·0317		1·629
32	13. 12. 3·0	11. 6. 55·8	15. 21·11	23·611	18·68 + 0·596	5·61	·1944	·2073	·9744	·0317		1·596
33	13. 12. 35·0	11. 7. 27·8	15. 22·13	23·537	17·73 + 0·568	5·54	·1947	·2092	·9739	·0319		1·568
34	13. 12. 52·0	11. 7. 44·8	15. 22·66	23·544	17·82 + 0·568	4·92	·1948	·2102	·9737	·0319		1·568
35	13. 13. 22·0	11. 8. 14·8	15. 23·61	23·491	17·24 + 0·547	4·55	·1952	·2120	·9732	·0321		1·547
36	13. 14. 10·0	11. 9. 2·8	15. 25·12	23·402	16·00 + 0·510	4·28	·1959	·2149	·9725	·0322		1·510
37	13. 14. 34·0	11. 9. 26·8	15. 25·91	23·343	15·25 + 0·486 δr	0 = 4·24	+ 0·1962 n	+ 0·2163 δ R.A.	+ 0·9721 δ N.P.D.	− 0·0323 δt	+ δ R	− 1·486 δr

EQUATIONS resulting from the MICROMETRIC OBSERVATIONS of the DISTANCE of CUSPS at MOKATTAM, Latitude, 30° 1′ 46″·4 N., Adopted Longitude, $2^h. 5^m. 6^s·58$ East of Greenwich.

Number.	Recorded Clock Time.	Corresponding Greenwich Sidereal Time.	Tabular Apparent Distance of Centers.	Recorded Micrometer Reading.	Inferred Distance of Near Limbs.	Relative Weight.	Resulting Equation for Distance of Centers of the Sun and Venus, assuming R = 976″·82, r = 31″·42, and Mean Solar Parallax = 8″·950 $\left(1 + \frac{n}{100}\right)$.
	h m s	h m s	′ ″	r	″		″ ″
1	13. 25. 59	11. 20. 51·8	15. 48·79	25·249	7·49 + 0·239 δr	9	0 = 4·10 + ·2037 n + ·2557 δR.A. + ·9608 δN.P.D. − ·0350 δt + δR − ·761 δr
2	13. 26. 26	11. 21. 18·8	15. 49·73	25·451	8·81 + 0·281	7	0 = 4·48 ·2040 ·2572 ·9604 ·0351 ·719
3	13. 26. 50	11. 21. 42·8	15. 50·56	25·489	9·05 + 0·288	6	0 = 3·89 ·2042 ·2585 ·9600 ·0352 ·712
4	13. 27. 10	11. 22. 2·8	15. 51·26	25·630	9·99 + 0·318	5	0 = 4·13 ·2043 ·2597 ·9596 ·0353 ·682
5	13. 27. 35	11. 22. 27·8	15. 52·14	25·802	11·23 + 0·362	4	0 = 4·49 ·2046 ·2610 ·9591 ·0354 ·638
6	13. 27. 53	11. 22. 45·8	15. 52·77	25·930	12·26 + 0·390	4	0 = 4·89 ·2047 ·2620 ·9588 ·0354 ·610
7	13. 28. 18	11. 23. 10·8	15. 53·67	26·021	13·02 + 0·416	3	0 = 4·75 ·2049 ·2634 ·9584 ·0355 ·584
8	13. 28. 44	11. 23. 36·8	15. 54·60	26·104	13·80 + 0·441	3	0 = 4·60 ·2052 ·2648 ·9579 ·0356 ·559
9	13. 29. 5	11. 23. 57·8	15. 55·32	26·145	14·19 + 0·453	2	0 = 4·27 ·2054 ·2660 ·9575 ·0357 ·547
10	13. 29. 23	11. 24. 15·8	15. 55·96	26·258	15·37 + 0·490 δr	2	0 = 4·81 + ·2054 n + ·2670 δR.A. + ·9572 δN.P.D. − ·0358 δt + δR − ·510 δr

COLLECTED EQUATIONS, FROM ALL OBSERVATIONS AT MOKATTAM.

The observations at Mokattam yield therefore the following FINAL EQUATIONS :—

(1) The Micrometric Measures of distance of Limbs—

$$0 = 4''\cdot 93 + ''\cdot 1851\, n + \cdot 1678\, \delta \text{R.A.} + \cdot 9821\, \delta \text{N.P.D.} - ''\cdot 0289\, \delta t + \delta \text{R} - 2\cdot 183\, \delta r;$$

(2) Mr. Newton's Internal Contact—

$$0 = 4''\cdot 06 + ''\cdot 2014\, n + \cdot 2434\, \delta \text{R.A.} + \cdot 9646\, \delta \text{N.P.D.} - ''\cdot 0342\, \delta t + \delta \text{R} - \quad \delta r;$$

(3) Miss Newton's Internal Contact—

$$0 = 3''\cdot 98 + ''\cdot 2014\, n + \cdot 2436\, \delta \text{R.A.} + \cdot 9645\, \delta \text{N.P.D.} - ''\cdot 0342\, \delta t + \delta \text{R} - \quad \delta r;$$

(4) Captain Browne's Internal Contact—

$$0 = 3''\cdot 95 + ''\cdot 2015\, n + \cdot 2436\, \delta \text{R.A.} + \cdot 9645\, \delta \text{N.P.D.} - ''\cdot 0342\, \delta t + \delta \text{R} - \quad \delta r;$$

(5) The Micrometric Measures of distance of Cusps—

$$0 = 4''\cdot 36 + ''\cdot 2044\, n + \cdot 2599\, \delta \text{R.A.} + \cdot 9595\, \delta \text{N.P.D.} - ''\cdot 0353\, \delta t + \delta \text{R} - 0\cdot 669\, \delta r;$$

(6) Captain Browne's External Contact—

$$0 = 4''\cdot 34 + ''\cdot 2149\, n + \cdot 3325\, \delta \text{R.A.} + \cdot 9328\, \delta \text{N.P.D.} - ''\cdot 0402\, \delta t + \delta \text{R} + \quad \delta r;$$

(7) Miss Newton's External Contact—

$$0 = 3''\cdot 60 + ''\cdot 2149\, n + \cdot 3334\, \delta \text{R.A.} + \cdot 9324\, \delta \text{N.P.D.} - ''\cdot 0402\, \delta t + \delta \text{R} + \quad \delta r;$$

(8) Mr. Newton's External Contact—

$$0 = 3''\cdot 21 + ''\cdot 2150\, n + \cdot 3339\, \delta \text{R.A.} + \cdot 9322\, \delta \text{N.P.D.} - ''\cdot 0402\, \delta t + \delta \text{R} + \quad \delta r.$$

On page 288 the final longitude of Mokattam is stated to be $2^{h}.\ 5^{m}.\ 6^{s}\cdot 24$, E., hence the above Equations require the correction obtained by making $\delta t = + 0^{s}\cdot 34$. It will be understood that δ R.A. and δ N.P.D. are the corrections required to Tabular R.A. and N.P.D. of Venus in seconds of arc referred to the center of the Sun.

After his return to England, Captain Browne made a determination of the value of a revolution of the screw of his double-image micrometer. The telescope was laid horizontally upon two tripod supports, and directed upon the transit instrument which had been used at Mokattam. A fixed web had been inserted in the transit-instrument in addition to the five webs moved by the micrometer-screw. In the focus of the eye-lens of the double-image micrometer were inserted two webs crossed. The reticule of the transit being sharply defined in the field of the double-image micrometer, the distance of the fixed web from the center movable web was measured by bringing their images into coincidence with the screw of the double-image micrometer, near the center of the field as defined by the crossed webs. In this manner,

between 1875, May 21 and June 2, some 60 comparisons were made of the relative values of revolutions of the two screws, using different parts of the screws, all showing a very close agreement. The half and quarter revolutions were also tested. It was found that 4·320 revolutions of the screw of the double-image micrometer were equivalent to one revolution of the screw of the transit-micrometer. The value of the latter had been very carefully determined at Mokattam to be 56″·43; re-determined at Greenwich, 56″·35 was obtained. Adopting 56″·40, the value of one revolution of the double-image screw is 13″·06.

The measured semidiameters of Venus in transit were—

$$2^{\text{rev}}\cdot419 \text{ and } 2^{\text{rev}}\cdot488,$$

corresponding to—

$$31''\cdot59 \text{ and } 32''\cdot50.$$

The mean of the two gives—

$$\delta\, r = + \cdot0''62,$$

which, although not very trustworthy, agrees very closely with the value obtained with telescopes of nearly the same aperture at Honolulu and Roorkee.

Time of Internal Contact at Mokattam inferred from the Cusp-Measures.

Taking $\delta\, r = + 0''\cdot62$, as above, the Greenwich Sidereal time of internal contact inferred from the first five cusp-measures is—

h m s		
11. 17. 9·2,	weight	9,
11. 16. 57·8,	„	7,
11. 17. 14·5,	„	6,
11. 17. 7·1,	„	5,
11. 16. 56·2,	„	4.

The mean with the weights assigned is—

$$11^{\text{h}}.\ 17^{\text{m}}.\ 5^{\text{s}}\cdot6,$$

which is from 10 to 12 seconds *earlier* than the telescopic contacts, proving that the cusp-measure is too great, as was found at Honolulu and Roorkee.

G. L. T.

MERIDIONAL AND ALTAZIMUTH OBSERVATIONS

AT

MOKATTAM,

IN TABULAR ARRANGEMENT.

TABLE XIII.—LEVEL ERROR of the TRANSIT INSTRUMENT at MOKATTAM, determined by SPIRIT-LEVEL.

[The sign + indicates that the East Pivot is low.]

Day.	Observer.	Sidereal Time of Level Determination.	Position of Head of Micrometer-Screw.	Level Error corrected for Inequality of Pivots.
1874.		h m		"
Nov. 3	B	23. 10	W	+ 1·79
	B	1. 0	W	+ 5·00
	B	1. 20	E	+ 5·26
4	B	23. 0	W	− 2·83
	N	1. 0	W	− 0·49
	N	1. 20	E	+ 1·42
5	N	1. 0	W	− 1·54
	N	1. 40	E	− 1·04
6	N	1. 5	W	− 7·27
	N	1. 30	E	− 4·40
7	B	23. 30	W	− 0·52
	N	1. 0	W	+ 10·28
	N	1. 30	E	+ 9·79
9	B	3. 0	W	− 1·21
10	B	20. 30	W	− 0·13
	B	23. 50	W	− 0·58
	B	1. 5	W	+ 0·59
	B	1. 30	E	+ 1·57
11	B	1. 0	W	− 1·24
	B	1. 30	E	+ 0·31
12	B	0. 16	W	− 2·32
	N	1. 0	W	− 0·79
	N	1. 20	E	− 0·35
13	B	23. 45	W	+ 0·17
	B	1. 10	W	+ 1·85
	B	1. 15	E	+ 4·09
14	B	23. 30	W	− 0·40
	B	1. 0	W	+ 1·04
	B	1. 25	E	− 1·28
	B	4. 35	E	− 2·63
	B	7. 30	E	− 2·15
15	B	21. 20	E	− 1·04
	B	23. 5	E	− 2·36
1874.		h m		"
Nov. 15	B	2. 5	E	− 1·82
	B	3. 0	W	− 3·34
	B	4. 30	W	− 0·13
	B	5. 10	W	− 0·49
	B	6. 20	E	+ 1·15
	B	6. 50	W	− 0·16
	B	8. 30	W	+ 3·98
16	B	1. 30	W	− 0·31
	B	1. 55	E	+ 2·32
18	B	23. 0	E	+ 0·34
	B	0. 0	W	− 0·91
	N	1. 0	W	+ 0·20
	N	1. 25	E	+ 1·45
19	B	0. 0	W	+ 1·97
	B	1. 0	W	+ 1·43
	B	1. 20	E	+ 2·38
20	B	1. 0	E	− 2·78
	B	1. 30	W	− 0·07
21	B	0. 0	W	+ 1·64
	B	1. 0	W	+ 4·64
	B	1. 25	E	+ 5·50
	B	2. 45	E	+ 4·78
	B	4. 15	W	+ 4·73
	B	7. 15	W	+ 1·04
	B	10. 0	W	− 2·02
22	B	23. 30	W	+ 1·40
	B	2. 5	W	+ 5·48
	B	2. 13	E	+ 5·26
	B	4. 10	E	− 0·26
	B	5. 40	E	− 1·58
23	N	1. 0	W	− 2·41
	N	1. 30	E	+ 0·46
24	N	1. 0	W	− 4·45
	N	2. 15	E	− 3·32

Day.	Observer.	Sidereal Time of Level Determination.	Position of Head of Micrometer-Screw.	Level Error corrected for Inequality of Pivots.
1874.		h m		″
Nov. 25	B	6. 15	E	+ 1·15
	N	1. 0	W	− 4·87
26	N	1. 0	W	+ 0·71
27	N	0. 10	W	− 0·88
	N	0. 50	W	+ 0·23
	N	1. 27	E	+ 0·46
28	N	0. 15	W	− 3·76
	N	1. 40	E	− 1·73
	N	3. 25	W	− 4·21
30	N	1. 0	W.	− 3·22
	N	1. 35	E	− 0·62
	N	3. 10	E	− 1·58
	N	4. 0	W	− 2·92
	B	11. 0	W	− 4·36
Dec. 1	B	0. 30	W	− 0·37
	B	1. 20	E	+ 3·13
2	B	0. 50	E	− 1·19
	B	1. 30	W	− 0·64
	B	1. 55	E	− 2·24
3	B	0. 50	E	− 1·46
	B	1. 20	W	− 2·05
	B	1. 55	E	+ 0·85
4	B	0. 10	E	− 0·29
	B	1. 0	E	− 2·21
	B	1. 30	W	− 3·31
	B	4. 15	W	− 0·61
	B	4. 45	E	− 2·75
	B	5. 15	W	+ 6·38
5	B	23. 50	W	− 2·38
	B	0. 40	E	+ 0·07
	B	1. 11	E	+ 1·09
	B	1. 30	W	− 1·24
	B	2. 10	W	+ 0·13
	B	4. 5	E	− 2·15
	B	4. 42	W	− 7·60
1874.		h m		″
Dec. 7	B	23. 25	W	− 0·46
	B	0. 10	W	− 0·64
	B	1. 0	E	− 1·12
	B	3. 10	E	+ 0·58
	B	3. 35	W	+ 2·48
8	B	23. 15	W	− 0·43
	B	23. 40	W	− 0·55
	B	0. 10	E	− 0·05
	B	0. 50	E	+ 0·82
	B	5. 55	E	− 0·29
	B	7. 40	E	+ 1·00
	B	10. 50	E	− 0·04
9	B	0. 15	E	+ 0·97
	B	1. 0	E	− 0·52
	B	1. 30	W	− 1·06
10	B	5. 30	W	− 2·05
	B	6. 20	E	+ 0·40
	B	7. 40	E	+ 2·17
11	B	0. 8	E	− 1·79
12	N	1. 0	W	− 0·85
	N	1. 25	E	+ 0·25
	N	2. 30	W	+ 0·53
14	B	0. 10	W	+ 2·06
	B	1. 0	E	+ 0·64
	B	1. 25	W	+ 0·08
	B	4. 20	W	+ 2·24
	B	5. 15	E	+ 3·13
	B	5. 45	E	+ 1·66
15	B	0. 18	E	+ 0·52
	B	1. 5	W	− 0·31
	B	1. 30	E	+ 1·39
	B	1. 42	W	+ 0·17
16	B	23. 28	W	− 0·91
21	B	0. 30	W	− 0·94
	B	1. 20	E	− 0·80

TABLE XIV.—COLLIMATION of the TRANSIT INSTRUMENT at MOKATTAM, determined by OBSERVATIONS of a CIRCUMPOLAR STAR, with reversed POSITIONS of the TRANSIT AXIS.

1874.		Approximate Local Mean Time.	Star.	Reading of the Micrometer for coincidence of Center Wire with the Optic Axis.	
				Observed.	Adopted.
		h m		r	r
October	30	10. 39	Polaris.........	19·789	19·740
	31	10. 35	,, ...	·722	,,
November	2	10. 27	,, ...	·676	,,
	3	10. 23	,, ...	·781	,,
	4	10. 19	,, ...	·698	,,
	5	10. 15	,, ...	·768	,,
	6	10. 11	,, ...	·701	,,
	7	10. 7	,, ...	·787	19·740
	10	9. 55	,, ...	·679	19·668
	11	9. 51	,, ...	·691	,,
	12	9. 47	,, ...	·627	,,
	13	9. 44	,, ...	·643	,,
	14	9. 40	,, ...	·655	,,
	15	14. 34	δ Ursæ Min. S.P.	·699	,,
	,,	15. 3	Cephei 51	·678	,,
	18	9. 24	Polaris.........	·679	19·668
	19	9. 20	,, ...	·692	19·683
	20	9. 16	,, ...	·677	,,
	21	9. 12	,, ...	·699	,,
	23	9. 4	,, ...	·672	,,
	24	9. 0	,, ...	·674	19·683
	27	8. 48	,, ...	·698	19·690
	28	8. 45	,, ...	·683	,,
	30	8. 37	,, ...	·703	,,
December	2	8. 29	,, ...	·678	,,
	3	8. 25	,, ...	·688	,,
	4	8. 21	,, ...	·663	,,
	5	8. 17	,, ...	·709	,,
	9	8. 1	,, ...	·682	,,
	12	7. 49	,, ...	·685	,,
	14	7. 41	,, ...	·704	,,
	15	7. 37	,, ...	·674	,,
	21	7. 14	,, ...	19·686	19·690

TABLE XV.—AZIMUTH ERROR of the TRANSIT INSTRUMENT at MOKATTAM.

[The sign + signifies that the optic axis points East of South.]

Day.	Stars employed.	Apparent Error of Azimuth.	Day.	Stars employed.	Apparent Error of Azimuth.
1874.		″	1874.		″
Nov. 3	Polaris and ε Piscium.	+10·83	Nov. 24	Polaris and γ_2 Ceti ...	− 4·28
4	,, κ Piscium.	+11·91	27	,, ν Piscium.	− 4·66
5	,, ν Piscium.	+13·40	28	,, η Piscium.	− 4·62
6	,, o_1 Eridani	+19·51	30	,, α Ceti....	− 7·05
7	,, ν Piscium.	+20·51			
10	,, ι Piscium.	+57·87*	Dec. 2	,, η Piscium.	− 7·86
11	,, ν Piscium.	+ 4·92	3	,, η Piscium.	−12·48
12	,, 12 Ceti...	+ 6·01	4	,, ν Piscium.	−11·02
13	,, η Piscium.	+ 7·51	5	,, η Piscium.	−14·90
14	,, ν Piscium.	+ 8·26	8	δ Ursæ Minoris S.P.	
15	δ Ursæ Minoris S.P.			and Cephei 51.....	−11·07
	and Cephei 51	+ 7·33	9	Polaris and ν Piscium.	−13·07
18	Polaris and ι Ceti	− 5·77	12	,, ν Piscium.	−13·86
19	,, ε Piscium.	− 4·57	14	,, ν Piscium.	−15·71
20	,, ο Piscium.	− 6·83	15	,, ε Piscium.	−16·45
21	,, ν Piscium.	− 7·96	21	,, 20 Ceti...	−16·56
23	,, η Piscium.	− 4·60			

* The azimuth adjustment was altered before and after the observations on November 10.

TABLE XVI.—MERIDIONAL TRANSITS observed at MOKATTAM, near CAIRO.

1874.	Observer.	Position of Micrometer Head.	Star and (Number of Wires when less than Five).	Mean observed Clock Time of Transit over the Center Wire.	Seconds of True Transit over the Meridian.	Star's Assumed Apparent R.A.	Clock apparently Slow.
				h m s	s	s	s
Nov. 14	B	W	ω Piscium................	23. 52. 38·84	39·33	53·32	+13·99
			α Andromedæ	0. 1. 40·97	41·30	55·38	14·08
			γ Pegasi	0. 6. 33·28	33·72	47·76	14·04
			ι Ceti	0. 12. 48·92	49·56	3·46	13·90
			44 Piscium................	0. 18. 45·10	45·64	59·60	13·96
			ε Andromedæ.............	0. 31. 42·54	42·86	56·98	14·12
			β Ceti	0. 37. 4·44	5·17	19·08	13·91
			δ Piscium................	0. 41. 57·27	57·76	11·78	14·02
			20 Ceti..................	0. 46. 22·64	23·21	37·17	13·96
			μ Andromedæ	0. 49. 34·64	34·89	48·98	14·09
			Polaris, 21ʳ·240	1. 9. 9·70	59·54	16·17	16·63
		E	Polaris, 21ʳ·240	1. 17. 37·40	4·73	16·17	11·44
			ν Piscium	1. 34. 41·93	41·79	55·75	13·96
			ο Piscium	1. 33. 34·04	33·87	47·77	+13·90

November 14. The transit micrometer was set at 19ʳ·740 for the clock stars.

1874.	Observer.	Position of Micrometer Head.	Star and (Number of Wires when less than Five).	Mean observed Clock Time of Transit over the Center Wire.	Seconds of True Transit over the Meridian.	Star's Assumed Apparent R.A.	Clock apparently Slow.
				h m s	s	s	s
Nov. 14	B	E	o_1 Eridani	4. 5. 32·18	32·08	46·31	+14·23
			γ Tauri	4. 12. 27·44	27·11	41·14	14·03
			ε Tauri	4. 21. 5·60	5·23	19·36	14·13
			α Tauri	4. 28. 31·61	31·27	45·20	13·93
			α Canis Minoris	7. 32. 31·25	31·05	45·24	14·19
			β Geminorum	7. 37. 26·00	25·53	39·65	14·12
Nov. 15	B	E	β Aquarii	21. 24. 43·46	43·40	57·62	14·22
			ζ Aquarii	21. 29. 50·62	50·57	4·78	14·21
			δ Capricorni	21. 39. 53·21	53·23	7·48	14·25
			16 Pegasi	21. 47. 7·64	7·28	21·52	14·24
			α Aquarii	21. 59. 6·72	6·63	20·91	14·28
			α Pegasi	22. 58. 17·50	17·17	31·51	14·34
			γ Piscium	23. 10. 26·53	26·32	40·61	14·29
			κ Piscium	23. 20. 17·00	16·80	31·07	14·27
			ι Piscium	23. 33. 16·86	16·64	30·92	14·28
			δ Sculptoris	23. 42. 10·32	10·38	24·82	14·44
			ω Piscium	23. 52. 39·24	39·01	53·32	14·31
			2 Ceti	23. 57. 5·99	5·96	20·11	14·15
			α Andromedæ	0. 1. 41·72	41·23	55·37	14·14
			γ Pegasi	0. 6. 33·80	33·48	47·75	14·27
			44 Piscium	0. 18. 45·58	45·38	59·59	14·21
			12 Ceti	0. 24. 25·32	25·18	39·50	14·32
			ε Andromedæ	0. 31. 43·24	42·74	56·97	14·23
			β Ceti	0. 37. 4·86	4·84	19·07	14·23
			α Arietis	1. 59. 54·02	53·65	7·85	14·20
			ξ_2 Ceti	2. 21. 16·90	16·68	31·10	14·42
		W	τ_1 Arietis	3. 13. 46·42	46·65	1·00	14·35
			o Tauri	3. 17. 50·86	51·18	5·64	14·46
			f Tauri	3. 23. 44·00	44·30	58·71	14·41
			ε Eridani	3. 26. 48·25	48·74	3·04	14·30
			11 Tauri	3. 34. 4·14	4·33	18·70	14·37
			δ Eridani	3. 37. 1·38	1·87	16·18	14·31
			η Tauri	3. 39. 49·09	49·30	3·63	14·33
			A_1 Tauri	3. 57. 4·14	4·36	18·69	14·33
			ω_1 Tauri	4. 1. 38·71	38·96	53·41	14·45
			o_1 Eridani	4. 5. 31·54	31·99	46·33	14·34
			γ Tauri	4. 12. 26·46	26·73	41·16	14·43
			β Tauri	5. 18. 9·07	9·34	23·67	14·33
			α Leporis	5. 26. 58·53	59·16	13·55	14·39
			ε Orionis	5. 29. 37·82	38·30	52·51	14·21
			κ Orionis	5. 41. 35·09	35·64	50·00	14·36
			α Orionis	5. 48. 9·78	10·19	24·46	14·27
			δ Ursæ Minoris S.P., $16^r·740$	6. 8. 55·50	9·65	26·68	17·03
		E	δ Ursæ Minoris S.P., $16^r·740$	6. 15. 11·30	12·19	26·68	14·49
			Cephei 51, $16^r·740$	6. 37. 32·40	12·57	28·61	16·04
		W	Cephei 51, $16^r·740$	6. 45. 10·30	13·10	28·61	+15·51

The Azimuth Error, November 15, $+7''·33$ for all the observations.
November 15. The transit micrometer was set at $19^r·740$ for all clock stars.

1874.	Observer.	Position of Micrometer Head.	Star and (Number of Wires when less than Five).	Mean observed Clock Time of Transit over the Center Wire.	Seconds of True Transit over the Meridian.	Star's Assumed Apparent R.A.	Clock apparently Slow.
				h m s	s	s	s
Nov. 15	B	W	γ Canis Majoris	6. 57. 51·29	51·90	6·28	+14·38
			51 Geminorum	7. 5. 56·66	57·03	11·49	14·46
			δ Geminorum	7. 12. 24·48	24·81	39·30	14·49
			γ Cancri	8. 35. 47·64	48·26	2·51	14·25
			ε Hydræ	8. 39. 53·96	54·65	8·78	14·13
Nov. 21	B	W	γ^1 Pegasi	0. 6. 30·36	30·52	47·71	17·19
			ι Ceti	0. 12. 46·34	46·28	3·41	17·13
			44 Piscium	0. 18. 42·08	42·13	59·55	17·22
			12 Ceti	0. 23. 22·16	22·15	39·46	17·31
			ε Andromedæ	0. 31. 39·36	39·92	56·93	17·01
			δ Piscium	0. 41. 54·52	54·81	11·74	16·93
			ε Piscium	0. 56. 9·83	10·12	27·41	17·29
			Polaris (2), $20^{r}\cdot990$	1. 9. 5·00	58·08	12·71	14·63
		E	Polaris, $21^{r}\cdot240$	1. 16. 34·70	53·10	12·71	19·61
			ν Piscium	1. 34. 38·93	38·82	55·74	16·92
			ο Tauri	3. 17. 48·77	48·65	5·69	17·04
			τ Arietis	3. 13. 44·10	44·09	1·05	16·96
			f Tauri	3. 23. 41·92	41·82	58·77	16·95
			ε Eridani	3. 26. 46·44	46·10	3·09	16·99
			11 Tauri	3. 33. 1·72	1·77	18·77	17·00
			η Tauri	3. 39. 46·66	46·70	3·70	17·00
			γ_1 Eridani	3. 51. 55·84	55·46	12·50	17·04
			A_1 Tauri	3. 57. 1·68	1·69	18·77	17·08
			ω_1 Tauri	4. 1. 36·49	36·46	53·49	17·03
			o_1 Eridani	4. 5. 29·52	29·24	46·40	17·16
		W	ε Tauri	4. 21. 1·82	2·25	19·47	17·22
			α Tauri	4. 28. 27·72	28·11	45·32	17·21
			μ Eridani	4. 38. 58·25	58·41	15·68	17·27
			ι Aurigæ (3)	4. 48. 33·77	34·42	51·68	17·26
			β Tauri	5. 18. 5·74	6·30	23·81	17·51
			α Leporis	5. 26. 56·44	56·46	13·66	17·20
			α Orionis	5. 48. 7·10	7·39	24·60	17·21
			α_2 Geminorum (4)	7. 26. 19·89	20·22	37·42	17·20
			α Canis Minoris	7. 32. 28·02	28·07	45·45	17·38
			β Geminorum	7. 37. 22·22	22·51	39·90	17·39
			γ_1 Leonis	10. 12. 46·54	46·52	3·93	17·41
			μ Hydræ (4)	10. 19. 44·48	44·19	1·72	17·53
			ρ Leonis	10. 25. 55·34	55·23	12·84	17·61
Nov. 22	B	W	ι Piscium	23. 33. 12·92	13·04	30·85	17·81
			δ Sculptoris (4)	23. 42. 7·02	6·90	24·85	17·95
			ω Piscium	23. 52. 35·15	35·28	53·25	17·97
			2 Ceti	23. 57. 2·12	2·09	20·04	17·95
			α Andromedæ	0. 1. 37·19	37·50	55·30	+17·80

November 21. A very high wind rendered the clock generally inaudible.
November 21–22. The transit micrometer was set at $19^{r}\cdot740$ for all clock stars.
Adopted Azimuth, November 22, $-6''\cdot06$.

1874.	Observer.	Position of Micrometer Head.	Star and (Number of Wires when less than Five).	Mean observed Clock Time of Transit over the Center Wire.	Seconds of True Transit over the Meridian.	Star's Assumed Apparent R.A.	Clock apparently Slow.
				h m s	s	s	s
Nov. 22	B	W	γ Pegasi	0. 7. 29·61	29·78	47·70	+17·92
			ι Ceti	0. 13. 45·49	45·49	3·40	17·91
			44 Piscium	0. 18. 41·52	41·61	59·54	17·93
			12 Ceti	0. 23. 21·38	21·43	39·45	18·02
			ε Andromedæ	0. 31. 38·62	38·94	56·92	17·98
			β Ceti	0. 37. 1·13	1·08	19·02	17·94
			α Arietis	1. 59. 49·65	50·20	7·87	17·67
		E	67 Ceti	2. 10. 27·88	27·69	45·30	17·61
			ξ_2 Ceti	2. 21. 13·39	13·34	31·12	17·78
			ε Tauri	4. 21. 1·98	1·59	19·48	17·89
			α Tauri (4)	4. 28. 27·85	27·45	45·34	17·89
			ι Aurigæ	4. 48. 34·39	34·06	51·70	17·64
			ε Orionis	5. 29. 35·29	34·80	52·66	17·86
			6 Cancri (4)	7. 55. 32·79	32·43	50·30	17·87
			15 Argûs	8. 1. 55·86	55·21	13·19	17·98
			β Cancri	8. 9. 26·48	26·04	43·96	17·92
Dec. 1	B	W	ε Piscium	0. 56. 4·78	4·55	27·35	22·80
			β Andromedæ	1. 2. 21·07	21·07	44·04	22·97
			θ Ceti	1. 17. 24·46	24·11	46·70	22·59
		E	ν Piscium	1. 35. 32·90	32·86	55·71	22·85
			ο Piscium	1. 38. 25·03	25·03	47·74	22·71
			β Arietis	1. 47. 21·30	21·41	44·25	22·84
Dec. 4	B	E	ι Ceti	0. 13. 39·31	38·73	3·29	24·56
			44 Piscium	0. 18. 35·16	34·72	59·45	24·73
			12 Ceti	0. 23. 15·14	14·63	39·36	24·73
			ε Andromedæ	0. 31. 32·06	31·93	56·82	24·89
			β Ceti (4)	0. 36. 54·73	54·05	18·92	24·87
			δ Piscium	0. 41. 47·33	46·94	11·65	24·71
			20 Ceti	0. 46. 12·86	12·37	37·05	24·68
			μ Andromedæ	0. 49. 24·06	24·06	48·79	24·73
			ε Piscium	0. 56. 2·96	2·57	27·33	24·76
			Polaris, $18^{r}\cdot190$	1. 8. 21·60	44·61	5·21	20·60
		W	Polaris, $18^{r}\cdot190$	1. 16. 14·00	36·06	5·21	29·15
			ν Piscium	1. 34. 31·26	30·73	55·70	24·97
			ο Piscium	1. 38. 23·28	22·78	47·73	24·95
			β Arietis	1. 47. 19·62	19·24	44·24	25·00
			ε Tauri	4. 20. 54·90	54·69	19·64	24·95
			α Tauri	4. 28. 20·84	20·59	45·49	24·90
			τ Tauri	4. 34. 20·38	20·22	45·16	24·94
			μ Eridani	4. 38. 51·40	50·93	15·85	24·92
		E	ι Aurigæ	4. 48. 27·12	26·92	51·92	25·00
			ε Leporis	4. 59. 46·98	46·20	11·13	24·93
			β Orionis	5. 8. 8·40	7·78	32·56	+24·78

The transit micrometer was set at $19^{r}\cdot740$ for all clock stars, November 22; and at $19^{r}\cdot690$, December 1 and 4. Adopted Azimuth Error, December 1, $-7''\cdot43$.

1874.	Observer.	Position of Micrometer Head.	Star and (Number of Wires when less than Five).	Mean observed Clock Time of Transit over the Center Wire.	Seconds of True Transit over the Meridian.	Star's Assumed Apparent R.A.	Clock apparently Slow.
				h m s	s	s	s
Dec. 5	B	W	2 Ceti	23. 56. 55·32	54·41	19·90	+25·49
			α Andromedæ	0. 1. 29·52	29·27	55·15	25·88
			γ Pegasi	0. 6. 22·22	21·75	47·58	25·83
			12 Ceti	0. 23. 14·44	13·70	39·35	25·65
			ε Andromedæ (4)	0. 31. 31·12	30·90	56·81	25·91
			β Ceti	0. 36. 54·28	53·34	18·91	25·57
		E	20 Ceti	0. 45. 12·14	11·55	37·05	25·50
			μ Andromedæ	0. 49. 23·10	23·21	48·78	25·57
			β Andromedæ	1. 2. 18·20	18·33	44·01	25·68
			Polaris, 18r·190	1. 8. 0·60	35·51	4·73	29·22
		W	Polaris, 18r·190	1. 16. 8·40	42·72	4·73	22·01
			η Piscium	1. 24. 22·52	22·15	47·75	25·60
			ν Piscium	1. 34. 30·60	30·08	55·70	25·62
			ο Piscium	1. 38. 22·52	22·06	47·72	25·66
		E	γ Tauri	4. 12. 16·08	15·65	41·41	25·76
			ε Tauri	4. 20. 54·34	53·96	19·66	25·70
			α Tauri	4. 28. 20·28	19·86	45·51	25·65
			τ Tauri	4. 34. 19·93	19·62	45·17	25·55
		W	μ Eridani	4. 38. 50·99	49·97	15·86	25·89
			ι Aurigæ	4. 48. 26·78	26·21	51·93	25·72
			ε Leporis	4. 59. 46·34	45·12	11·14	26·02
Dec. 7	B	W	ι Piscium	23. 33. 4·20	3·80	30·71	26·91
			ι Ceti	0. 12. 37·02	36·42	3·26	26·84
			12 Ceti	0. 23. 12·88	12·36	39·33	26·97
			ε Andromedæ	0. 31. 29·87	29·80	56·79	26·99
		E	δ Piscium	0. 41. 45·10	44·69	11·63	26·94
			20 Ceti	0. 46. 10·50	9·97	37·03	27·06
			μ Andromedæ	0. 49. 21·88	21·92	48·76	26·84
			ε Piscium	0. 56. 0·65	0·24	27·31	27·17
			ο Tauri	3. 17. 38·95	38·67	5·78	27·11
			f Tauri	3. 23. 32·06	31·82	58·87	27·05
			ε Eridani	3. 26. 36·43	35·89	3·17	27·28
Dec. 8	B	W	κ Piscium	23. 20. 3·71	3·31	30·84	27·53
			ι Piscium	23. 33. 3·50	3·14	30·70	27·56
			2 Ceti	23. 56. 52·96	52·34	19·87	27·53
			α Andromedæ	0. 1. 27·56	27·47	55·12	27·65
			γ Pegasi	0. 6. 20·16	19·90	47·55	27·65
		E	ι Ceti	0. 12. 36·24	35·75	3·25	27·50
			44 Piscium	0. 18. 32·27	31·92	59·41	27·49
			12 Ceti	0. 23. 12·36	11·94	39·32	27·38
			β Ceti (2)	0. 36. 52·26	51·66	18·88	27·22
			δ Piscium (1)	0. 41. 44·65	44·36	11·62	27·26
			20 Ceti (1)	0. 46. 9·94	9·54	37·02	27·48
			α Orionis	5. 47. 57·54	57·21	24·94	+27·73

Adopted Azimuth Error, December 7, −12″·41.
December 5 to 8. The transit micrometer was set at 19r·690 for all clock stars.

1874.	Observer.	Position of Micrometer Head.	Star and (Number of Wires when less than Five).	Mean observed Clock Time of Transit over the Center Wire.	Seconds of True Transit over the Meridian.	Star's Assumed Apparent R.A.	Clock apparently Slow.
				h m s	s	s	s
Dec. 8	B	E	δ Ursæ Min. S.P., 19r·023 (3)	6. 12. 47·50	54·10	20·91	+26·81
			Cephei 51, 15r·190 (2).....	6. 35. 5·50	8·68	36·18	27·50
			δ Leonis (2)	11. 6. 59·68	59·54	27·06	27·52
			δ Crateris (3)............	11. 12. 37·59	37·04	4·77	27·73
			τ Leonis (3)..............	11. 21. 2·25	1·91	29·81	27·90
Dec. 9	B	E	12 Ceti..................	0. 23. 11·47	10·96	39·31	28·35
			ε Andromedæ	0. 31. 28·50	28·49	56·77	28·28
			β Ceti	0. 36. 51·36	50·65	18·87	28·22
			20 Ceti..................	0. 46. 9·35	8·87	37·01	28·14
			μ Andromedæ	0. 49. 20·38	20·54	48·73	28·19
		E	Polaris, 18r·940 (2)	1. 10. 5·00	35·48	2·30	26·82
		W	Polaris, 18r·190	1. 16. 2·80	32·94	2·30	29·36
			η Piscium (3).............	1. 24. 20·07	19·75	47·72	27·97
			ν Piscium................	1. 34. 28·10	27·66	55·67	28·01
			ο Piscium (4)	1. 38. 20·07	19·67	47·70	28·03
			β Arietis.................	1. 47. 16·38	16·13	44·22	28·09
			ν Ceti	2. 28. 51·44	51·00	19·19	28·19
			γ^2 Ceti	2. 36. 22·06	21·59	49·83	28·24
Dec. 10	H	W	α Columbæ...............	5. 34. 40·26	39·21	8·70	29·49
			α Orionis	5. 47. 56·48	55·97	24·97	29·00
			1 Geminorum	5. 56. 3·00	2·71	32·01	29·30
			ν Orionis	5. 59. 57·94	57·54	26·78	29·24
		E	μ Geminorum	6. 14. 55·60	55·49	24·59	29·10
			β Canis Minoris (4)	7. 19. 53·88	53·68	22·83	29·15
			α_2 Geminorum	7. 26. 8·60	8·79	38·03	29·24
			α Canis Minoris...........	7. 32. 17·10	16·85	45·97	29·12
			β Geminorum	7. 37. 11·36	11·46	40·50	29·04
Dec. 14	B	W	γ Pegasi	0. 6. 16·11	15·93	47·49	31·56
			12 Ceti..................	0. 23. 8·07	7·56	39·26	31·70
			ε Andromedæ	0. 31. 24·80	24·92	56·70	31·78
		E	β Ceti	0. 36. 47·80	46·96	18·81	31·85
			δ Piscium................	0. 41. 40·18	39·79	11·57	31·78
			20 Ceti	0. 46. 5·60	5·05	36·96	31·91
			ε Piscium................	0. 55. 55·77	55·38	27·25	31·87
			Polaris, 18r·440 (4)	1. 8. 26·75	24·16	58·32	34·17
		W	Polaris, 18r·190	1. 15. 50·40	28·58	58·32	29·74
			ν Piscium................	1. 34. 24·06	23·60	55·64	32·04
			α Arietis.................	1. 59. 35·78	35·63	7·81	32·18
			ξ_1 Ceti	2. 5. 51·07	50·66	22·76	32·10
			67 Ceti	2. 10. 13·82	13·17	45·25	32·08
			α Tauri..................	4. 28. 13·74	13·60	45·59	31·99
			τ Tauri..................	4. 34. 13·22	13·22	45·26	32·04
			μ Eridani (4).............	4. 38. 44·37	43·88	15·94	+32·06

December 9 to 14. The transit micrometer was set at 19r·690 for all clock stars.

1874.	Observer.	Position of Micrometer Head.	Star and (Number of Wires when less than Five).	Mean observed Clock Time of Transit over the Center Wire.	Seconds of True Transit over the Meridian.	Star's Assumed Apparent R.A.	Clock apparently Slow.
				h m s	s	s	s
Dec. 14	B	W	ι Aurigæ	4. 48. 19·70	19·92	52·04	+32·12
			β Orionis	5. 8. 1·16	0·61	32·67	32·06
		E	β Tauri	5. 17. 51·98	52·09	24·23	32·14
			δ Orionis	5. 25. 6·22	5·81	38·02	32·21
			α Leporis	5. 26. 42·65	41·92	14·00	32·08
			ε Orionis	5. 29. 21·43	21·00	53·01	32·01
			α Columbæ	5. 34. 37·36	36·29	8·75	32·46
			κ Orionis	5. 41. 18·93	18·34	50·51	32·17
Dec. 15	B	E	ι Ceti	0. 12. 31·31	30·60	3·18	32·58
			44 Piscium	0. 18. 27·27	26·76	59·35	32·59
			12 Ceti	0. 23. 7·27	6·66	39·25	32·59
			ε Andromedæ	0. 31. 24·04	24·04	56·69	32·65
		W	β Ceti	0. 36. 47·17	46·26	18·80	32·54
			δ Piscium	0. 41. 39·68	39·22	11·56	32·34
			20 Ceti	0. 46. 5·10	4·47	36·95	32·48
			μ Andromedæ	0. 49. 16·04	16·18	48·66	32·48
			ε Piscium	0. 55. 55·12	54·66	27·25	32·59
			Polaris, 21ʳ·190	1. 7. 49·80	27·07	57·46	30·39
		E	Polaris, 21ʳ·190	1. 15. 40·50	22·01	57·46	35·45
			η Piscium	1. 24. 15·26	15·04	47·68	32·64
			ν Piscium	1. 34. 23·38	22·98	55·63	32·65
			ο Piscium	1. 38. 15·36	15·04	47·66	32·62
		W	β Arietis	1. 47. 11·68	11·48	44·18	32·70
			α Arietis	1. 59. 35·30	35·14	7·80	32·66
			ξ_1 Ceti	2. 5. 50·51	50·09	22·75	32·66
			67 Ceti	2. 10. 13·33	12·67	45·24	+32·57

December 15. The transit micrometer was set at 19ʳ·690 for all clock stars.

TABLE XVII.—ERRORS and RATES of the TRANSIT-CLOCK at MOKATTAM.

Approximate Local Mean Solar Time.		Observer.	Approximate Sidereal Time.	Adopted Clock Slow.	Clock's Loss in preceding 24h. Sidereal.	Adopted Losing Rate.
1874.	d h		h m	s	s	s
Nov.	4. 10	B	0. 37	+ 21·93	+ 0·08	+ 0·09
	5. 11	B	2. 16	22·04	0·10	0·15
	13. 9	B	0. 47	13·71	0·08	0·19
	14. 11	B	2. 25	14·03	0·30	0·29
	15. 11	B	2. 20	14·31	0·28	0·29
	18. 8	B	23. 52	15·27	0·33	0·46
	19. 9	B	0. 32	15·78	0·50	0·65
	20. 10	B	1. 32	16·62	0·81	0·64
	21. 12	B	4. 1	17·14	0·47	0·62
	22. 11	B	2. 48	17·87	0·77	0·78
	24. 11	B	2. 45	19·46	0·80	0·68
	27. 9	B	1. 43	20·97	0·51	0·56
	28. 10	B	2. 0	21·55	0·57	0·50
	30. 12	B	4. 30	22·31	0·36	0·48
Dec.	1. 9	B	1. 23	22·79	0·55	0·58
	2. 9	B	1. 43	23·42	0·62	0·69
	3. 9	B	1. 35	24·17	0·75	0·71
	4. 10	B	2. 30	24·87	0·67	0·75
	5. 9	B	2. 19	25·69	0·83	0·78
	7. 8	B	1. 3	27·00	0·67	0·59
	8. 9	B	2. 2	27·57	0·55	0·58
	9. 8	B	1. 17	28·16	0·61	0·73
	10. 13	B	6. 32	29·19	0·85	0·70
	11. 7	B	0. 25	29·60	0·55	0·64
	12. 9	B	2. 5	30·37	0·72	0·75
	14. 10	B	3. 18	32·01	0·80	0·69
	15. 8	B	1. 6	32·59	0·64	0·73
	16. 6	B	23. 58	33·37	0·82	0·79
	21. 7	B	0. 46	+ 36·50	+ 0·62	+ 0·62

TABLE XVIII.—COMPARISON of the ALTAZIMUTH CLOCK at MOKATTAM with the TRANSIT-CLOCK by the Intervention of the SOLAR CHRONOMETER FRODSHAM $\frac{3}{3308}$. Observer, B.

Day.		Time by Transit-Clock at Comparison.	Chronometer Time at Comparison with		Time by Altazimuth Clock at Comparison.	Altazimuth Clock Slow on Sidereal Time.	Hourly Rate of Altazimuth Clock.
			Transit-Clock.	Altazimuth Clock.			
1874.		h m s	h m s	h m s	h m s	m s	s
November	4	23. 42. 8·0	8. 47. 5·0	8. 40. 10·0	23. 36. 37·0	− 1. 3·45	− 0·98
	,,	3. 46. 0·0	12. 50. 17·0	12. 57. 10·5	3. 54. 24·0	− 1. 7·66	
	5	22. 12. 50·0	7. 14. 5·0	7. 30. 30·0	22. 31. 5·0	− 1. 25·42	− 0·95
	,,	2. 40. 30·0	11. 41. 1·0	11. 45. 0·0	2. 46. 21·0	− 1. 29·46	
	27	22. 11. 55·0	5. 46. 20·0	5. 54. 20·0	22. 19. 56·0	+ 21·1	− 0·13
	,,	7. 30. 12·0	15. 3. 5·5	15. 9. 11·5	7. 36. 20·0	+ 19·9	
	28	22. 20. 0·0	5. 50. 27·5	5. 59. 19·5	22. 28. 54·0	+ 20·8	+ 0·04
	,,	4. 4. 39·0	11. 34. 10·0	11. 43. 49·0	4. 14. 20·0	+ 21·0	

TABLE XIX.—ZENITH DISTANCES of STARS observed near the MERIDIAN with the

1874.	Observer.	Star.	Time by the Altazimuth Clock.	Lamp Right or Left.	Circle-Reading corrected for Runs of Micrometers.	Level Indication additive.	Barometer and External Thermometer.	Refraction.
			h m s		° ′ ″	″		″
Nov. 4	B	Polaris	1. 6. 53·0	R	211. 52. 6·7	87·7	29in·46	90·9
	B	„	1. 15. 43·0	L	329. 3. 10·6	78·2	61°·0	90·9
	B	α Persei	3. 7. 6·0	L	289. 55. 36·9	70·9		19·7
	B	„	3. 16. 3·0	R	251. 4. 42·5	89·5		19·6
5	B	Polaris	1. 15. 57·0	L	329. 3. 8·5	77·3	29in·50	90·2
	B	„	1. 24. 9·0	R	211. 52. 5·5	87·6	65°·7	90·2
27	B	γ Piscium...	23. 11. 13·0	R	243. 2. 34·4	63·1	29in·44	28·7
	B	„ ...	23. 19. 7·0	L	297. 57. 36·0	89·5	64°·0	28·9
	B	12 Ceti.....	0. 20. 56·0	L	305. 8. 8·7	66·6		38·2
	B	„	0. 27. 57·0	R	235. 46. 1·0	97·8		38·3
	B	β Ceti	0. 35. 51·0	R	221. 46. 6·2	89·7		62·8
	B	„	0. 41. 36·0	L	319. 9. 44·8	66·5		62·9
	B	ε Piscium ...	0. 52. 1·0	L	293. 17. 11·3	74·1		21·7
	B	„ ...	1. 0. 15·0	R	247. 37. 47·8	90·8		21·7
	B	Polaris	1. 8. 14·0	L	329. 2. 53·5	91·2		90·3
	B	„	1. 16. 14·0	R	211. 52. 9·0	75·2		90·3
	B	α Persei	3. 11. 42·0	L	289. 50. 55·1	89·5		19·5
	B	„	3. 18. 32·0	R	251. 4. 4·7	74·6		19·5
	B	α Aurigæ ...	5. 4. 55·0	R	254. 36. 56·8	80·3		15·7
	B	„ ...	5. 13. 18·0	L	286. 20. 22·7	83·1		15·7
	B	δ Orionis ...	5. 21. 1·0	R	240. 1. 44·9	84·6		32·5
	B	„ ...	5. 28. 23·0	L	300. 52. 44·7	82·5		32·5
	B	α Orionis ...	5. 42. 59·0	L	293. 7. 39·9	86·7	29in·44	23·10
	B	„ ...	5. 50. 7·0	R	247. 48. 45·5	85·5	64°·0	23·10

VERTICAL CIRCLE of the ALTAZIMUTH at MOKATTAM, and INFERRED CO-LATITUDE.

Zenith Point, including Zero of Level. Observed.	Zenith Point, including Zero of Level. Adopted.	Concluded Zenith Distance.	Reduction to the Meridian.	Star N. or S. of Zenith.	Tabular Apparent N.P.D. of Star.	Inferred Co-latitude.
270°. 28′		° ′ ″	″		° ′ ″	° ′ ″
″ 62·9	″ 62·5	58. 36. 59·0	2·7	N.	1. 21. 20·9	59. 58. 17·2
		58. 36. 57·2	0·1		,,	18·0
62·1	62·5	19. 28. 5·0	296·6	N.	40. 35. 4·1	12·5
		19. 23. 10·1	0·8		,,	13·3
61·5	61·5	58. 36. 54·5	0·6	N.	1. 21. 20·4	14·3
		58. 36. 58·6	4·2		,,	14·3
60·4	60·4	27. 25. 51·6	3·0	S.	87. 24. 4·8	16·2
		27. 30. 34·4	285·4		,,	16·2
50·8	51·9	34. 41. 1·6	16·8	S.	94. 38. 56·1	12·3
		34. 41. 51·4	64·3		,,	9·0
51·9	51·9	48. 42. 18·8	2·6	S.	108. 40. 29·4	13·2
		48. 43. 2·3	46·0		,,	13·1
52·1	51·9	22. 49. 55·2	7·3	S.	82. 47. 58·3	12·4
		22. 49. 55·0	7·5		,,	10·8
54·0	51·9	58. 37. 3·1	1·5	N.	1. 21. 13·1	14·8
		58. 36. 58·0	0·6		,,	10·5
52·9	51·9	19. 23. 52·2	38·0	N.	40. 34. 59·2	11·4
		19. 23. 52·1	39·8		,,	14·5
49·5	51·9	15. 50. 50·5	21·2	N.	44. 7. 48·1	17·4
		15. 53. 9·6	165·1		,,	12·6
53·0	51·9	30. 26. 14·9	61·4	S.	90. 23. 26·6	13·1
		30. 25. 47·8	32·1		,,	10·9
51·1	51·9	22. 40. 37·8	113·5	S.	82. 36. 56·1	11·8
		22. 38. 54·0	18·1		,,	59. 58. 20·2

TRANSIT OF VENUS, 1874.

PART II.

EXPEDITION TO EGYPT

(continued).

Section 2.

DETERMINATION

OF THE

LONGITUDE OF ALEXANDRIA

BY LOCAL TRANSITS AND EXCHANGE OF TELEGRAPH SIGNALS WITH MOKATTAM STATION,

FROM THE

OBSERVATIONS OF SAMUEL HUNTER, Esq.

CONTENTS.

LONGITUDE OF ALEXANDRIA.

EXTRACT from a LETTER from MR. S. HUNTER to the ASTRONOMER ROYAL.

My work in Egypt in connection with the Transit of Venus may be divided into three periods:—

First, at Cairo, assisting Captain Browne in transporting material, &c., to Mokattam, erecting huts, &c., from the 15th to 26th October 1874.

Second, at Alexandria in connection with the determination of longitude, October 27 to November 25.

Third, at Suez (where I observed the Transit), from November 26 to December 24.

The instruments with which I was furnished were the property of the *Royal Astronomical Society*, and consisted of—

(1.) An *equatorial* of 4·6 inches aperture, by T. Cooke and Sons, of York, driven by clockwork, and furnished with Solar eye-piece and divided eye-glass double-image micrometer. This instrument on landing in Egypt was stored in Suez until my return there.

(2.) A Transit instrument (Sheepshanks No. 1) with aperture of 2·6 inches, mounted on a portable metal stand, which was fastened by two screws to a stone slab, resting on a brick pier. The wire frame carried nine fixed vertical wires and two horizontal ones; there were also two movable vertical wires connected with the micrometer screw. Power used = 77 diameters.

I had the box, 2-day chronometers *Loseby* 102, regulated to *sidereal* time, beating half seconds, and the *solar* chronometer *Hewitt* 890, also beating half seconds.

The work in Cairo requires no further observation. At Alexandria the first duty was the selection of a site as convenient to the Telegraph Office as possible. Having examined several places, I decided on using the roof of the Hôtel de l'Europe, as it appeared most suitable. It is distant five minutes walk from the Telegraph Office. The walls of the Hôtel de l'Europe are 2 feet 3 inches thick, and just over the intersection of two partition walls of the same thickness the transit pier was erected.

On October 30 I commenced observing with the transit instrument in order to determine the wire intervals, value of micrometer screw, and pivot

errors of the transit, as this instrument came from Mr. Simms' factory only just in time to be packed up before leaving Greenwich; consequently all instrumental corrections had to be determined before a single observation could be reduced. I soon discovered that the micrometer-screw was decidedly drunken, and was compelled to abandon its use. This entailed very serious loss of time every night, and compelled me to trust to observing the pole star in both positions of the instrument over the fixed wires for collimation, as well as for azimuth errors.

Having no covering for the instrument, I carried it into my room and put it in its box each night.

On November 24 I packed the instruments and returned to Cairo.

S. HUNTER.

(*Continued on page* 333.)

MERIDIONAL OBSERVATIONS at ALEXANDRIA.

Mr. Hunter's observations for local time were continuous from 1874, October 30 to November 23; but have special value only on those nights when signals were exchanged with Mokattam.

The *Level Error* was determined by a striding spirit-level graduated from the center outwards in the old way; 40 divisions were equivalent to one minute of arc.

After his return to England Mr. Hunter carefully determined the *Pivot Correction* to be $0''\cdot88$, positive with the Micrometer Head East.

The *Equatorial Intervals* of the nine vertical wires were determined from numerous transits of circumpolar stars over the entire set. The correction to reduce the mean of the wires to the center wire was $1''\cdot58$, positive with Micrometer West.

The *Collimation Error* of the center wire was determined by observations of polar stars with reversed positions of the Transit axis.

The *Azimuth Error* has been obtained, and the reductions effected in the same manner as at other stations.

The *Diurnal Aberration* is taken account of as a correction to the Longitude.

In adopting the Error of the observing Chronometer (*Loseby* 102) equal weight has been given to the observations in each of the reversed positions of the transit instrument, irrespective of the number of stars observed.

It was Mr. Hunter's custom to compare the two chronometers (by coinci-

dence of beats) on concluding the star observations. Thus each chronometer was available for carrying on time. The Errors and Rates of Hewitt 890 thus obtained are given separately, page 327. The only occasion, however, when they can be employed with sensible advantage is on November 22, when there were no star observations.

The position of the Hôtel de l'Europe is taken with sufficient accuracy from the Admiralty Chart, viz. :—

2,940 British yards East and 400 yards North of the Light-House on EUNOSTES POINT;

620 yards East and 1,940 yards South of the ancient PHAROS;

the approximate Latitude being 31°. 11′. 55″. N.

MERIDIONAL TRANSITS observed at ALEXANDRIA by MR. S. HUNTER.
1874, November 14.

Position of Micrometer Head.	Star.	Mean observed Time by Loseby 102 of Transit over the Center Wire.	Seconds of True Transit over the Meridian.	Star's assumed Apparent R.A.	Loseby 102 apparently Slow.
		h m s	s	s	s
E	20 Ceti	0. 44. 49·62	51·68	37·21	+ 105·53
	μ Andromedæ	0. 48. 3·09	3·32	48·98	105·66
E	Polaris (5)	1. 12. 48·31	31·38	15·93	104·55
W	Polaris (4)	1. 13. 34·24	29·72	15·93	106·21
	ξ^1 Ceti	2. 4. 36·77	37·19	22·80	105·61
	67 Ceti	2. 8. 58·52	59·59	45·29	105·70
	ξ^2 Ceti	2. 19. 44·95	45·37	31·10	105·73
	ν Ceti	2. 27. 32·89	33·49	19·16	105·67
	δ Ceti	2. 31. 18·36	19·17	4·96	105·79
	γ^2 Ceti	2. 35. 3·53	4·21	49·78	105·57
	σ Arietis	2. 42. 50·02	50·12	35·79	105·67
	ϵ Arietis	2. 50. 18·68	18·52	4·26	105·74
W	δ Arietis	3. 2. 43·50	43·42	29·25	+ 105·83

Level Error.

h m			″
1. 0	Sid.	(E.)	− 0·21
1. 25	„	(W.)	− 2·42
2. 55	„	(W.)	− 1·74

Collimation Error by *Polaris*, 7″·6 (+ E., − W) (adopted, 7″·9).
Azimuth Error by *Polaris* and 67 Ceti, +41″·7 (adopted).

MERIDIONAL TRANSITS observed at ALEXANDRIA by MR. S. HUNTER.
1874, November 15.

Position of Micrometer Head.	Star.	Mean observed Time by Loseby 102 of Transit over the Center Wire.	Seconds of True Transit over the Meridian.	Star's assumed Apparent R.A.	Loseby 102 apparently Slow.
		h m s	s	s	s
W	α Gruis	21. 58. 32·29	35·45	20·26	+104·81
	θ Aquarii	22. 8. 28·13	29·32	13·44	104·12
	γ Aquarii	22. 13. 25·60	26·59	11·22	104·63
	σ Aquarii	22. 22. 15·21	16·55	1·21	104·66
	η Aquarii	22. 27. 9·80	10·75	55·27	104·52
	ζ Pegasi	22. 33. 28·04	28·54	12·95	104·41
	μ Pegasi	22. 42. 13·36	13·17	57·56	104·39
	Fomalhaut	22. 48. 57·27	59·39	44·10	104·71
W	α Pegasi	22. 56. 46·81	47·06	31·51	104·45
E	δ Ursæ Minoris S.P.	6. 10. 9·37	41·32	26·98	105·66
	Cephei 51 (5)	6. 40. 19·03	42·76	28·36	105·60
W	Cephei 51 (3)	6. 40. 41·23	42·76	28·36	+105·60

Level Error.

h m			″
20. 45	Sid.	(W.)	+ 1·67
22. 54	,,	(W.)	− 0·81
6. 8	,,	(E.)	+ 0·05
6. 27	,,	(E.)	− 1·97
6. 34	,,	(E.)	− 0·88
6. 49	,,	(W.)	− 1·29

Collimation Error by Cephei 51, 7″·9 (+ E., − W.) (adopted).

Collimation Error, Nov. 16, Polaris, 8″·1 (,, ,,)

Azimuth Error by δ Ursæ Minoris S.P. and Cephei 51, + 40″·5 (adopted).

November 16. Azimuth Error by *Polaris* and 67 Ceti, + 40″·8.

MERIDIONAL TRANSITS observed at ALEXANDRIA by MR. S. HUNTER.
1874, November 21.

Position of Micrometer Head.	Star.	Mean observed Time by Loseby 102 of Transit over the Center Wire.	Seconds of True Transit over the Meridian.	Star's assumed Apparent R.A.	Loseby 102 apparently Slow.
		h m s	s	s	s
W	ζ Pegasi	22. 34. 28·17	29·48	12·88	+ 43·40
	μ Pegasi	22. 43. 13·68	14·38	57·48	43·10
	Fomalhaut	22. 50. 57·93	0·61	44·01	43·40
	12 Ceti	0. 22. 55·69	56·62	39·46	42·84
	ε Andromedæ	0. 31. 14·80	14·01	56·91	42·90
	β Ceti	0. 36. 34·61	36·19	19·03	42·84
	δ Piscium	0. 41. 28·41	28·77	11·73	42·96
	Polaris (5)	1. 14. 43·95	29·84	12·68	42·84
E	Polaris (4)	1. 13. 50·19	29·83	12·68	42·85
	β Arietis	1. 47. 0·43	1·47	44·27	42·80
	64 Ceti	2. 4. 0·95	2·49	45·58	43·09
	ξ^1 Ceti	2. 5. 38·30	39·84	22·81	42·97
	67 Ceti	2. 10. 0·20	2·39	45·30	42·91
	ξ^2 Ceti	2. 20. 46·59	48·13	31·12	42·99
	ν Ceti	2. 28. 34·50	36·21	19·18	42·97
	δ Ceti	2. 32. 20·09	21·94	4·98	43·04
	γ^2 Ceti	2. 36. 4·98	6·78	49·82	43·04
	σ Arietis	2. 43. 51·66	52·91	35·82	42·91
	11 Tauri	3. 32. 35·09	36·00	18·77	42·77
	δ Eridani	3. 36. 30·89	33·35	16·23	42·88
	ζ Ursæ Minoris	3. 47. 35·25	45·83	29·74	43·91
	A^1 Tauri	3. 56. 34·75	35·78	18·78	43·00
	o^1 Eridani	4. 5. 1·09	3·37	46·37	+ 43·00

Level Error.

h m			″
22. 55	Sid.	(W.)	+ 12·95
23. 0	,,	Level adjusted.	
0. 26	,,	(W.)	− 1·48
0. 54	,,	(W.)	− 6·61
1. 5	,,	(W.)	− 6·31
1. 25	,,	(E.)	− 1·48
2. 40	,,	(E.)	− 2·38
4. 5	,,	(E.)	+ 1·46

Collimation Error, November 19, by *Polaris*, 8″·94 (+ E., − W.).

Collimation Error, November 21, by *Polaris*, 8″·20 (+ E., − W.) (adopted).

Azimuth Error, November 19, by *Polaris* and 67 Ceti, + 45″·01.

Azimuth Error, November 21, by β Ceti and *Polaris*, + 42″·56 (adopted).

Azimuth Error, November 21, by ζ Ursæ Minoris and A^1 Tauri, + 45″·55.

MERIDIONAL TRANSITS observed at ALEXANDRIA by MR. S. HUNTER.
1874, November 23.

Position of Micrometer Head.	Star.	Mean observed Time by Loseby 102 of Transit over the Center Wire.	Seconds of True Transit over the Meridian.	Star's assumed Apparent R.A.	Loseby 102 apparently Slow.
		h m s	s	s	s
E	δ Sculptoris	23. 41. 37·59	40·78	24·72	+ 43·94
	ω Piscium	23. 52. 8·00	9·49	53·25	43·76
	2 Ceti	23. 56. 33·66	36·24	19·93	43·69
	α Andromedæ	0. 1. 11·22	11·73	55·29	43·56
	γ Pegasi	0. 6. 3·05	4·21	47·69	43·48
	Polaris (3)	1. 13. 49·75	30·19	11·92	41·73
W	Polaris (4)	1. 14. 42·67	26·88	11·92	45·04
	67 Ceti	2. 9. 0·94	1·53	45·30	43·77
	ξ^2 Ceti	2. 20. 47·32	47·20	31·12	43·92
	ν Ceti	2. 28. 35·45	35·52	19·18	+ 43·66

Level Error.

h m			″
23. 29	Sid.	(E.)	− 3·50
2. 3	„	(W.)	−10·07

Collimation Error by *Polaris* $\binom{7''\cdot6}{8''\cdot9}$ (+ E., − W.) (adopted, 8″·2).
Azimuth Error by Polaris and 67 Ceti, + 40″·95 (adopted).

ERRORS and RATES of the SIDEREAL CHRONOMETER LOSEBY 102 from the Observations at ALEXANDRIA. Observer, R. HUNTER.

Approximate Local Mean Time.		Sidereal Time.	Loseby 102 slow on Alexandria Sidereal Time.	Loss in the preceding 24 hours Sidereal.	Adopted Losing Rate.
1874.	h	h m	s	s	s
Nov.	13, 14	4. 7	+ 106·30	..	..
	14, 10	1. 41	+ 105·65	− 0·72	− 1·02
	15, 7	22. 30	+ 104·52	− 1·32	− 0·37
	16, 10	1. 21	+ 105·18	+ 0·59	..
			†		
	19, 10	2. 22	+ 42·93	..	..
	21, 9	1. 21	+ 43·02	+ 0·04	0·00
	23, 9	1. 10	+ 43·72	+ 0·35	+ 0·35

† Advanced one minute.

COMPARISONS of CHRONOMETERS at ALEXANDRIA (by coincidence of beats).

Day.	Loseby 102, Sidereal.	Hewitt 890, Solar.	Day.	Loseby 102, Sidereal.	Hewitt 890, Solar.
1874.	h m s	h m s	1874.	h m s	h m s
Nov. 13	7. 0. 0·0	15. 28. 6·0	Nov. 20	3. 43. 7·0	11. 43. 6·5
	7. 3. 4·0	15. 31. 9·5		3. 46. 12·0	11. 46. 11·0
	7. 6. 8·0	15. 34. 13·0		3. 52. 16·0	11. 52. 14·0
	7. 9. 16·0	15. 37. 20·5			
	7. 12. 16·0	15. 40. 20·0	21	5. 20. 47·0	13. 16. 32·0
				5. 26. 49·0	13. 22. 35·0
14	4. 23. 43·0	12. 48. 17·5		5. 29. 51·0	13. 25. 36·5
	4. 26. 46·0	12. 51. 20·0		12. 37. 46·0	20. 32. 21·0
	4. 36. 2·0	1. 0. 34·5		12. 43. 49·0	20. 38. 23·0
	4. 39. 0·0	13. 3. 32·0			
	12. 24. 14·0	20. 47. 29·5	22	0. 15. 23·0	8. 8. 3·5
	12. 27. 19·0	20. 50. 34·0		0. 18. 28·0	8. 11. 8·0
				8. 43. 15·0	15. 34. 42·0
15	(*a*) 23. 18. 42·0	7. 40. 10·5		8. 46. 13·0	15. 37. 39·5
	23. 21. 47·0	7. 43. 14·0		8. 49. 17·0	15. 40. 43·0
	9. 34. 50·0	17. 54. 36·0			
	9. 37. 54·0	(*b*) 17. 57. 40·5	23	9. 21. 50·0	17. 9. 4·0
				9. 24. 53·0	(*g*) 17. 7. 6·5
16	(*c*) 2. 21. 1·0	(*d*) 11. 57. 58·5			
	2. 44. 4·0	(*e*) 11. 51. 1·0			
17	(*f*) 2. 56. 48·0	10. 10. 55·5			
	2. 2. 58·0	10. 16. 4·5			
18	2. 29. 42·0	10. 39. 46·5			
	2. 32. 44·0	10. 42. 48·0			
19	2. 58. 16·0	11. 2. 19·5			
	3. 1. 18·0	11. 5. 21·0			
	3. 4. 22·0	11. 8. 24·5			

		h m s
(*a*),	probably,	23. 18. 43·0
(*b*),	,,	17. 57. 39·5
(*c*),	,,	2. 41. 1·0
(*d*),	,,	10. 57. 58·5
(*e*),	,,	11. 1. 1·0
(*f*),	,,	1. 56. 48·0
(*g*),	,,	17. 12. 6·5

ERRORS and RATES of the MEAN SOLAR CHRONOMETER HEWITT 890 from the COMPARISONS with LOSEBY 102, made near the Epochs of Observations of Stars.

Day.	Local Mean Time.	Hewitt 890 Slow on Alexandria Mean Time.	Loss in the preceding 24 hours Solar.	Adopted Losing Rate.	——
1874.	h m	s	s	s	
Nov. 13	15. 30	+ 103·53	..	..	An independent rate of *Hewitt* 890 is obtained by its comparisons by telegraph with the Transit Clock at Mokattam (*see next page*).
14	12. 58	+ 103·92	+ 0·43	+ 0·24	
15	7. 42	+ 103·95	+ 0·04	+ 0·74	
16	10. 58	+ 105·60†	+ 1·44	..	
19	11. 8	+ 106·95	..	..	
21	13. 26	+ 108·28	+ 0·64	+ 0·91	
23	9. 0	+ 110·43‡	+ 1·18	+ 1·18	

† Possibly some error; the comparisons are difficult to understand.

‡ The Error, November 23, is obtained by combining comparisons made 17 hours before and 8 hours after the observations for local time.

ERRORS and RATES of the SOLAR CHRONOMETER HEWITT 890 on MOKATTAM MEAN SOLAR TIME from the exchange of Signals between MOKATTAM and ALEXANDRIA.

(Extracted from the Section *Longitude of Mokattam*, page 278.)

1874.	Time by Hewitt 890.	Hewitt 890 Slow on Mokattam Mean Solar Time.	Adopted Hourly Losing Rate.
	h m	m s	s
Nov. 14	14. 6	+ 7. 16·39	
	19. 58	+ 7. 16·58	+ ·032
15	9. 33	+ 7. 17·02	+ ·032
	16. 1	+ 7. 17·33	+ ·048
21	14. 14	+ 7. 20·88	....
	19. 47	+ 7. 21·07	+ ·034
22	9. 2	+ 7. 21·74	+ ·050
	14. 39	+ 7. 22·09	+ ·062

DIFFERENCE of LONGITUDE between MOKATTAM and ALEXANDRIA (HÔTEL DE L'EUROPE).

1874.	Time by Hewitt 890.	Hewitt 890 slow on Alexandria Mean Time.	Hewitt 890 slow on Mokattam Mean Time, from above Table.	Alexandria West of Mokattam.	Weight.
	h m	m s	m s	m s	
Nov. 14	12. 58	+ 1. 43·92	+ 7. 16·35	5. 32·43	1
*15	7. 42	+ 1. 43·95	+ 7. 16·95	5. 33·00	½
*16	10. 58	+ 1. 45·60	+ 7. 18·31	5. 32·71	½
21	13. 26	+ 1. 48·28	+ 7. 20·85	5. 32·57	1
22	13. 26	+ 1. 49·46	+ 7. 22·01	5. 32·55	1

Combining the values in the preceding Table with the weights assigned, we have for the Apparent Longitude of Alexandria (Hôtel de l'Europe) West of Mokattam Station—

$$5^{m}.\ 32^{s}\cdot 60.$$

This depends upon Captain Browne's and Mr. Hunter's methods of observing transits of stars, and requires correction also for personal equation in the method of giving and receiving signals.

* On November 15 the transits at Alexandria are unsatisfactory (the instrument was not reversed). On November 16 there was no exchange of signals with Mokattam, but good transits were obtained at Alexandria. The results for November 15 and 16 have each been allowed one-half weight only.

In the section *Longitude of Mokattam* (page 285) it will be seen that H gives signals $0^s.005$ earlier than B, and receives signals $0^s.062$ earlier. On this account, therefore, the longitude of Alexandria West of Mokattam requires the corrections $+ 0^s.002$ and $- 0^s.031$.

After their return to England, viz., in 1875, April, Captain Browne and Mr. Hunter compared their methods of observing transits in the following manner:—

The transit instrument that had been in use at Mokattam was mounted in the grounds of the Royal Observatory, Greenwich, as before mentioned (page 287), and the beats of the Sidereal Standard Clock were rendered audible to the observer by introducing a *sounder* into the circuit connecting the Sidereal Standard Clock with the chronograph. It was hoped by this arrangement to obtain the absolute personal equations of both observers, but it was afterwards discovered that the beat of the sounder was subject to a sensible retardation, which destroyed the intended comparison with the Greenwich standard observer on those nights, but did not interfere with the relative comparisons of Captain Browne and Mr. Hunter. The following numbers are the Excess of the Sidereal Standard Clock Slow, by B and H respectively, over that by the Greenwich standard observer C + the retardation of the sounder:—

1875.	B	H
	s	s
April 12,	+ 0·50	
13,		+ 0·41
14,	+ 0·41	
17,	+ 0·29	+ 0·39
19,		+ 0·44
Mean	+ 0·40	+ 0·41

It has therefore been considered that there is no sensible difference between their methods of observing transits; consequently no correction is required to the longitude on this account.

Mr. Hunter having omitted the correction for diurnal aberration, sensibly $0^s.02$ for all clock stars, a correction of $- 0^s.02$ is applied to the longitude of Alexandria West of Mokattam.

We have then for final result—

	h m s
Apparent longitude of Mokattam, East of Alexandria, as deduced from the preceding table	0. 5. 32·60
Correction for personal equation between B and H—	
In giving signals, + 0·002; In receiving signals, — 0·031	—0·03
Correction for personal equation between B and H in the manner of observing star transits................	0·00
Correction for diurnal aberration of clock stars	—0·02
CONCLUDED LONGITUDE of ALEXANDRIA, WEST OF MOKATTAM	0. 5. 32·55
The CONCLUDED LONGITUDE of MOKATTAM STATION, EAST OF GREENWICH, has been already found	2. 5. 6·24
CONCLUDED LONGITUDE of ALEXANDRIA (Hôtel de l'Europe) EAST OF GREENWICH	1. 59. 33·69

G. L. T.

TRANSIT OF VENUS, 1874.

PART II.

EXPEDITION TO EGYPT

(continued).

Section 3.

OBSERVATIONS AT SUEZ.

By SAMUEL HUNTER, Esq.

CONTENTS.

OBSERVATIONS AT SUEZ.

Extract from a Letter from Mr. S. Hunter to the Astronomer Royal (*continued from page* 322).

Suez was reached late on the evening of the 26th November. The next morning I examined the site occupied by Mr. Gill, of Lord Lindsay's Expedition,* and rode round the town. Mr. Gill's site was situated in the lowest part of the town, surrounded by buildings, with the greater portion of the town between it and the Eastern and Southern horizon (as it is on the north-western side of Suez), so that the smoke and heated air from the buildings would most probably prevent definition when the Sun was so low as at the time of transit; besides, the Sun would be hidden by the buildings until 10° or 15° high. I found a small artificial platform about 40 feet high, on which the Khedive's Châlet is built, situated on the north side of Suez among the débris of the ancient Arsinoë, which had a clear Eastern and Southern horizon, free from intrusion and from smoke. The only defect arose from the looseness of the soil, causing the level readings to vary a good deal.

The day being Friday, the Mahometan Sunday, I could not prevail on the Consul to call on the Governor of Suez that day, in order to obtain permission to erect my hut and instruments at the Châlet; but next day we called about ten o'clock, and obtained the necessary permission, and a guard of soldiers to prevent intrusion. Before night I had all my cases on the platform, the equatorial pier built, and the hut erected, and on the 30th commenced observations with the transit instrument. I got a telegraph line erected from my hut to the office of the Eastern Telegraph Company in Suez, and had comparisons with Mokattam on December 4, 5, 7, and 14.

Observing with the transit instrument and reducing the observations, erecting and adjusting the Equatorial, together with the telegraphic comparisons, fully occupied my time until the time of the Transit of Venus. On several mornings preceding I observed the Sun rise (to test my Equatorial, driving clock, &c.), but to my astonishment I could not get the Sun's image

* Suez was the starting point of Lord Lindsay's chronometric expedition, connecting Suez, Mauritius, Rodriguez, and Aden. Lord Lindsay afterwards determined the difference of longitude between the points occupied by Mr. Gill and Mr. Hunter, thus completing the chain from Greenwich to Aden.

defined at all. As I got good definition of stars with it, I examined the colored glasses, and found that the center of each of them had been partially melted with the Sun's rays at some previous period;* consequently they destroyed the image, so that I had to use a colored glass held in the hand for observation of contact. The colored glass of the double-image micrometer was free from this defect.

REPORT of Mr. HUNTER on his OBSERVATION of the EGRESS of VENUS, 1874, DECEMBER 8.

By $4^h. 30^m.$ on the morning of the 9th of December I was at my hut, and had all the arrangements made long before sunrise, although the sky was almost covered with cloud. A clear strip on the Eastern horizon gave me the hope of seeing the Sun rise, but even this was covered over just a few minutes before the Sun rose, so that I did not see the Sun at all until about half an hour before contact, when I saw it only for a second. In about 10 minutes the Sun was again visible through cloud, and continued visible until the end, although at times covered so densely with cloud that I had to remove the colored glass in order to see it. The instant that it became visible I commenced the measurement of the apparent diameter of Venus, then the distances from the limb, until it was time to remove the double-image micrometer and observe contact. The power used for this purpose = 126, being a positive eye-piece with a glass prism in front of it, forming a solar eye-piece.

The formation of the ligament took place, without the slightest warning, at about 5″ (by rough estimation) from the apparent limb of the Sun—the cloud being then rather dense—but good definition. That this was a well-marked phenomenon is evidenced by the fact that Mr. Isaac Engleson, who was observing with a telescope of mine outside my hut, and distant about 13 feet (we could not see each other), using a Solar chronometer, noted this time $1^s{\cdot}25$ later than I did. His time, reduced to local Sidereal, was $13^h. 26^m. 53^s{\cdot}90$, mine $13^h. 26^m. 52^s{\cdot}65$. At the time we both noted as follows:—Mr. Engleson: "I think I recorded it $2^s.$ or $3^s.$ late." S. H.: "Might be a second or a second and a half late," as "I took a second glance to assure myself that it was not an optical deception." Mr. Engleson had no previous training on the Model—coming out as a volunteer at his own cost—and took this as true contact. His time of formation of cusps is later

* The instrument was in Mr. Hunter's possession for five months before he started for Egypt.

Transit of Venus 1874. at Suez.

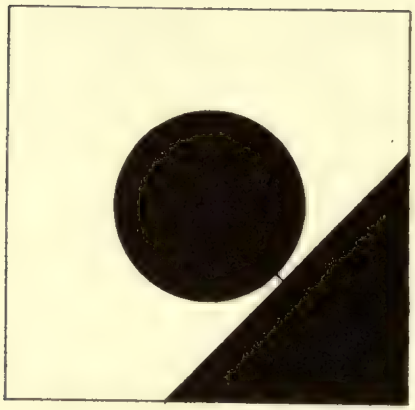


Fig. 1.

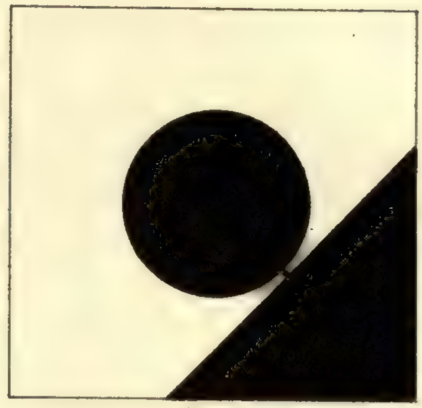


Fig. 2.

Fig. 3.

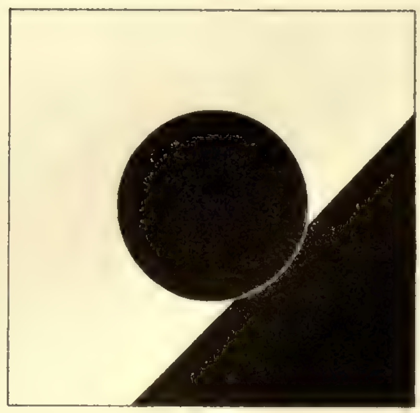


Fig. 4.

Dangerfield Lith. 22 Bedford St Covent Garden.

than mine by $13^s \cdot 66$. I estimated true contact at $13^h. 27^m. 37^s \cdot 65$, the black drop being then well marked, and as dark as the body of the planet, cusps being observed well marked at $13^h. 29^m. 10^s \cdot 65$. These times are corrected for clock error and rate.

The rim of silvery light round the edge of Venus on leaving the Sun's limb was very beautiful and striking, but as soon as I saw that it belonged to the planet, and likely to last a considerable time, I commenced measuring cusps with the double-image micrometer. I obtained 8 measures of the diameter of Venus, 25 distances of limbs, and 75 cusp measures, the whole of which I regret to say proved useless, as, in determining afterwards the value of the screw of the double-image micrometer, I found it totally untrustworthy, as already reported to you.*

The time noted for last contact is very uncertain, the undulations of the Sun's edge being then very great (all cloud had just cleared off the Sun), so that the time noted is that when I found myself certain the notch did not recur, and is consequently too late probably by 5^s. or 10^s.

Transit observations, the telegraphic comparison on the 14th, and the necessary reductions, occupied my time until December 24, when I was enabled to pack up my instruments and hut ready for shipment.

At Suez the Equatorial was situated 11 feet 9 inches due West of the Transit instrument. From the latter to the nearest (S.E.) corner of the Châlet the distance was 91 feet 8 inches; to the Flagstaff, 48 feet 6 inches.

Details of the Observation of Egress.

Times of Phenomena of INTERNAL CONTACT, recorded from the Sidereal Chronometer *Loseby* 102.

h m s		
13. 26. 34,	Fig, 1, Plate XI.	Just a line, no more.
13. 27. 19,	Fig. 2, „	Now well marked.
13. 28. 52,	Fig. 3, „	Cusps well marked.

EXTERNAL CONTACT.

13. 56. 15·0. The notch has now become undiscernible.

I tried to get measures several times between this and the last observation, but the boiling of the Sun's edge from the atmosphere was nearly as great as the planet's notch, if not quite so.

---

* Mr. Hunter's micrometer measures have, in consequence, not been published.

The definition throughout has been imperfect, clouds continually passing. I saw the Sun for the first time, for a second, about 15 minutes before the first observation, and not again until one minute or so before the first recorded measure. The power used for the observation of contact was 126. An assistant recorded the time and observations.

For some time after contact, until $13^h. 31^m.$ at least, the edge of Venus was brilliantly illuminated—that edge which had just left the Sun—so that for a little I thought the Sun was appearing behind it still, although the cusps were then well marked, as in Fig. 4, Plate XI. It was a clear silvery light, like the edge of a cloud.

There was no distortion of the planet during the observation, except at the first formation of the cusps, when, as seen in the double-image micrometer, the points were much blunted. No blunted points were observed during the disappearance of the following limb.

S. HUNTER.

For Mr. Hunter's observations are obtained the following local and Greenwich times and final equations, assuming the Latitude 29°. 58′. 23″. N., Longitude $2^h. 10^m. 13^s \cdot 17$, E.:—

Phase observed.	Recorded Chronometer Time.	Correction of Chronometer.	Local Sidereal Time.	Greenwich Sidereal Time.	Local Tabular Distance of Centers.
	h m s	s	h m s	h m s	′ ″
Internal contact ...	13. 27. 19	+ 18·52	13. 27. 37·52	11. 17. 24·35	15. 41·63
External contact...	13. 56. 15	+ 18·52	13. 56. 33·52	11. 46. 20·35	16. 46·37

Taking $R = 16'. 16''\cdot82$, $r = 31''\cdot42$, and the Mean Solar Parallax $= 8''\cdot950 \left(1 + \frac{n}{100}\right)$, we have for the internal contact—

$$+3''\cdot77 = -''\cdot2021\, n - \cdot2443\, \delta\, \text{R.A.} - \cdot9643\, \delta\, \text{N.P.D.} + ''\cdot0342\, \delta t - \delta R + \delta r,$$

and for the external contact—

$$+1''\cdot87 = -''\cdot2150\, n - \cdot3351\, \delta\, \text{R.A.} - \cdot9314\, \delta\, \text{N.P.D.} + ''\cdot0404\, \delta t - \delta R - \delta r.$$

The transit instrument used by Mr. Hunter at Suez has already been described in the account of operations at Alexandria. At Suez it was mounted on a pier of masonry to the S.E. of the Châlet of the KHEDIVE, on the north side of the town, as described in Mr. Hunter's letter.

The system of wires remained intact during the observations.

The transits of stars were reduced by Mr. Hunter on the spot. The Collimation and Azimuth Errors were adopted for each night as found from the observations of *Polaris*. The Level Error was *not* corrected for inequality of the size of the pivots, as this correction was afterwards determined in England.

The Clock Error, however, as found by Mr. Hunter, requires no further correction on account of instrumental errors, since stars were observed with the transit axis in both positions, and the adopted clock error is the mean of the two positions of the instrument, irrespective of the number of stars observed in each position.

The Diurnal Aberration of the Clock Stars is taken into account as a final correction to the Longitude.

MERIDIONAL TRANSITS observed at SUEZ with the SIDEREAL CHRONOMETER LOSEBY 102.

1874, December 3.

Star.	Position of the Micrometer Head.	Mean observed Chronometer Time of Transit over the Center Wire.	Seconds of True Transit over the Meridian.	Seconds of Star's Assumed Apparent R.A.	Chronometer apparently Slow.
		h m s	s	s	s
α Andromedæ.........	E	0. 1. 32·44	32·69	55·20	+ 22·51
γ Pegasi	E	0. 6. 25·10	25·15	47·62	22·47
ι Ceti.................	E	0. 12. 41·14	40·90	3·31	22·42
Polaris (4)	E	1. 12. 30·58	...	6·48	...
Polaris (4)	W	1. 11. 59·19	...	6·48	...
α Arietis.............	W	1. 59. 44·00	44·94	7·87	22·93

Sidereal Time of Level Determination.	Level Error.
h m	″
?	+ 8·58†
0. 55 E	+ 7·80
1. 28 W	+ 9·22

† Mean of 20.

COLLIMATION ERROR.

December 1, by Polaris, 1″·07 (− E, + W).
" 2, " 4·97 (− E, + W).
" 3, " 5·65 (− E, + W) (adopted).

AZIMUTH ERROR.

December 1, by Polaris and 67 Ceti, −0″·45.
" 2, by Polaris and β Arietis, − 4·57.
" 3, by Polaris and ι Ceti, − 7·00 (adopted).

Meridional Transits observed at Suez, 1874, December 4.

Star.	Position of the Micrometer Head.	Mean observed Chronometer Time of Transit over the Center Wire.	Seconds of True Transit over the Meridian.	Seconds of Star's Assumed Apparent R.A.	Chronometer apparently Slow.
		h m s	s	s	s
γ Pegasi	W	0. 6. 24·11	24·99	47·61	22·62
ι Ceti	W	0. 12. 40·56	41·12	3·32	22·20
44 Piscium	W	0. 18. 36·36	37·03	59·47	22·44
12 Ceti	W	0. 23. 16·41	17·01	39·38	22·37
ε Andromedæ	W	0. 31. 33·21	34·36	56·83	22·47
β Ceti	W	0. 36. 56·22	56·68	18·95	22·27
Polaris (5)	W	1. 11. 51·54	...	6·37	...
Polaris (4)	E	1. 12. 25·70	...	6·37	...
β Arietis	E	1. 47. 21·79	22·11	44·26	22·15
α Arietis	E	1. 59. 45·15	45·42	7·87	22·45

Sidereal Time of Level Determination.	Level Error.
h m	″
0. 45 W	+ 8·55
1. 24 E	+13·77
1. 32 E	+11·50

Remarks, December 4. Strong wind; chronometer almost inaudible.

Collimation Error by Polaris, 7″·62 (−E, + W) (adopted).
Azimuth Error by Polaris and β Ceti, −8″·21 (adopted).

1874, December 5.

Star.	Position of the Micrometer Head.	Mean observed Chronometer Time of Transit over the Center Wire.	Seconds of True Transit over the Meridian.	Seconds of Star's Assumed Apparent R.A.	Chronometer apparently Slow.
		h m s	s	s	s
44 Piscium	W	0. 18. 37·09	38·04	59·47	21·43
12 Ceti	W	0. 23. 17·06	17·92	39·37	21·45
ε Andromedæ	W	0. 31. 33·86	35·39	56·83	21·44
β Ceti	W	0. 36. 56·77	57·41	18·93	21·52
62 Piscium	W	0. 41. 25·66	26·77	48·13	21·36
Polaris (5)	W	1. 11. 45·84	...	5·39	...
Polaris (4)	E	1. 12. 17·70	...	5·39	...
ο Piscium	E	1. 38. 26·16	26·55	47·76	21·21
β Arietis	E	1. 47. 22·48	23·06	44·26	21·20
α Arietis	E	1. 59. 46·06	46·66	7·87	21·21

Sidereal Time of Level Determination.	Level Error.
h m	″
0. 28 W	+14·43
1. 3 W	+15·67
1. 30 E	+14·92

Collimation Error by Polaris, 6″·07 (−E, + W) (adopted).

Azimuth Error by Polaris and β Ceti, −8″·34 (adopted).

Meridional Transits observed at Suez, 1874, December 6.

Star.	Position of the Micrometer Head.	Mean observed Chronometer Time of Transit over the Center Wire.	Seconds of True Transit over the Meridian.	Seconds of Star's Assumed Apparent R.A.	Chronometer apparently Slow.
		h m s	s	s	s
12 Ceti	E	0. 23. 17·90	18·39	39·57	21·18
ε Andromedæ	E	0. 31. 35·03	35·86	57·02	21·16
δ Piscium	E	0. 41. 50·17	50·78	11·83	21·05
20 Ceti	E	0. 46. 15·60	16·12	37·25	21·13
Polaris (5)	E	1. 12. 33·05	...	4·82	...
Polaris (4)	W	1. 11. 59·19	...	4·82	...
β Arietis	W	1. 47. 21·65	23·27	44·27	21·00
α Arietis	W	1. 59. 45·32	46·96	7·86	20·90
ξ^1 Ceti	W	2. 6. 0·30	1·75	22·84	21·09
67 Ceti	W	2. 10. 22·92	24·19	45·28	21·09

Sidereal Time of Level Determination.	Level Error.
h m	″
0. 55 E	+ 15·33
1. 2 E	+ 16·23
1. 24 W	+ 17·13
1. 31 W	+ 19·35

Collimation Error by Polaris, 5″·81 (—E, + W) (adopted).

Azimuth Error, Polaris and 20 Ceti, —1″·08 (adopted).

1874, December 7.

Star.	Position of the Micrometer Head.	Mean observed Chronometer Time of Transit over the Center Wire.	Seconds of True Transit over the Meridian.	Seconds of Star's Assumed Apparent R.A.	Chronometer apparently Slow.
		h m s	s	s	s
2 Ceti	W	23. 56. 58·72	59·57	19·89	20·32
α Andromedæ	W	0. 1. 32·75	34·83	55·15	20·32
γ Pegasi	W	0. 6. 25·47	27·10	47·58	20·48
ι Ceti	W	0. 12. 41·94	42·98	3·28	20·30
ε Andromedæ	E	0. 31. 35·75	37·12	56·80	19·68
β Ceti (3)	E	0. 36. 58·94	59·06	18·91	19·85
Polaris (3)	E	1. 12. 0·52	...	4·25	...

Sidereal Time of Level Determination.	Level Error.
h m	″
0. 18 W	+ 22·72
0. 54 E	+ 23·10

Remarks: Observations interrupted by clouds.

AZIMUTH ERROR.

By Polaris and β Ceti, —14″·0.
By β Ceti and ε Andromedæ, — 8·0.
By 2 Ceti and α Andromedæ, —11·2.
(Adopted Azimuth Error, —11·1).
Adopted Collimation Error, 5·8 (—E, + W).

Meridional Transits observed at Suez, 1874, December 8.

Star.	Position of the Micrometer Head.	Mean observed Chronometer Time of Transit over the Center Wire.	Seconds of True Transit over the Meridian.	Seconds of Star's Assumed Apparent R.A.	Chronometer apparently Slow.
		h m s	s	s	s
62 Piscium	W	0. 41. 28·95	28·96	48·12	19·16
20 Ceti	W	0. 46. 17·84	17·75	37·06	19·31
Polaris (2)	W	1. 12. 8·02	...	3·66	...
Polaris (2)	E	1. 12. 29·17	...	3·66	...
ο Piscium	E	1. 39. 28·87	28·46	47·73	19·27
ξ^1 Ceti (4)	E	2. 6. 4·11	3·69	22·82	19·13
67 Ceti	E	2. 10. 26·83	26·23	45·30	19·07
α Ceti (4)	E	2. 55. 26·47	26·12	45·23	19·11

Sidereal Time of Level Determination.	Level Error.
h m	″
0. 15 W	− 0·30
0. 55 W	+ 1·12
1. 30 E	+ 1·24
3. 17 E	+ 5·10

Collimation Error by Polaris, 4″·42 (−E, + W) (adopted).

Azimuth Error by Polaris and 20 Ceti, −10″·1.

1874, December 9.

Star.	Position of the Micrometer Head.	Mean observed Chronometer Time of Transit over the Center Wire.	Seconds of True Transit over the Meridian.	Seconds of Star's Assumed Apparent R.A.	Chronometer apparently Slow.
		h m s	s	s	s
Polaris (3)	W	1. 11. 51·89	...	3·04	...
Polaris (3)	E	1. 12. 13·31	...	3·04	...
ο Piscium	E	1. 38. 30·29	30·09	47·73	17·64
β Arietis	E	1. 47. 26·49	26·50	44·25	17·75
α Arietis	E	1. 59. 50·08	50·13	7·85	17·72
ξ^1 Ceti	E	2. 6. 5·16	4·94	22·82	17·88
ξ^2 Ceti	W	2. 21. 13·00	13·42	31·14	17·72
ν Ceti	W	2. 29. 0·98	1·35	19·22	17·87
δ Ceti	W	2. 32. 46·81	47·07	5·02	17·95
γ^2 Ceti	W	2. 36. 31·57	31·90	49·86	17·96

Sidereal Time of Level Determination.	Level Error.
h m	″
0. 8 W	+ 6·00
0. 10 W	+ 4·99
1. 25 E	+ 4·69
2. 8 E	+ 7·57
2. 15 W	+ 9·07
2. 45 W	+ 7·95

Collimation Error by Polaris, 4″·41 (−E, + W) (adopted).

Azimuth Error by Polaris and ο Piscium, −14″·2 (adopted).

Meridional Transits observed at Suez, 1874, December 11.

Star.	Position of the Micrometer Head.	Mean observed Chronometer Time of Transit over the Center Wire.	Seconds of True Transit over the Meridian.	Seconds of Star's Assumed Apparent R.A.	Chronometer apparently Slow.
		h m s	s	s	s
ω Piscium (5)	W	23. 52. 36·15	36·09	53·09	17·00
2 Ceti	W	23. 57. 3·32	2·94	19·87	16·93
44 Piscium	W	0. 18. 42·46	42·31	59·38	17·07
12 Ceti	W	0. 23. 22·47	22·24	39·31	17·07
20 Ceti	W	0. 46. 20·14	19·95	37·04	17·09
Polaris (2)	W	1. 11. 53·06	...	1·60	...
Polaris (2)	E	1. 12. 18·85	...	1·60	...
α Arietis	E	1. 59. 50·85	50·65	7·84	17·19
ξ^1 Ceti	E	2. 6. 6·01	5·58	22·82	17·24
ν Ceti	E	2. 29. 2·31	1·81	19·22	17·41
α Ceti (6)	E	2. 55. 28·31	27·80	45·23	17·43

Sidereal Time of Level Determination.	Level Error.
h m	″
23. 45 W	− 1·72
1. 0 W	− 0·90
2. 59 E	+ 5·25

Collimation Error by Polaris, 6″·87 (−E, + W) (adopted).

Azimuth Error by Polaris and 12 Ceti, −14″·6 (adopted).

1874, December 14.

Star.	Position of the Micrometer Head.	Mean observed Chronometer Time of Transit over the Center Wire.	Seconds of True Transit over the Meridian.	Seconds of Star's Assumed Apparent R.A.	Chronometer apparently Slow.
		h m s	s	s	s
α Andromedæ	W	0. 1. 38·04	37·81	55·06	17·25
γ Pegasi	W	0. 6. 30·86	30·31	47·51	17·20
ι Ceti	W	0. 12. 47·01	46·02	3·22	17·20
44 Piscium	W	0. 18. 42·91	42·11	59·38	47·27
12 Ceti	E	0. 23. 23·77	22·27	39·28	17·01
Polaris (3)	E	1. 12. 11·77	...	59·07	...
Polaris (3)	W	1. 11. 43·63	...	59·07	...
α Arietis (6)	E	1. 59. 51·91	50·92	7·82	16·90
ξ^1 Ceti	E	2. 6. 6·90	5·65	22·78	17·13
67 Ceti	E	2. 10. 29·81	28·25	45·26	17·01

Sidereal Time of Level Determination.	Level Error.
h m	″
22. 12 W	−10·76
23. 55 W	− 7·39
1. 7 E	− 4·87
1. 55 W	− 7·54
2. 13 E	− 5·48

Collimation Error by Polaris, 6″·13 (−E, + W) (adopted).

Azimuth Error by Polaris and 12 Ceti, −22″·2 (adopted).

Meridional Transits observed at Suez, 1874, December 18.

Star.	Position of the Micrometer Head.	Mean observed Chronometer Time of Transit over the Center Wire.	Seconds of True Transit over the Meridian.	Seconds of Star's Assumed Apparent R.A.	Chronometer apparently Slow.
		h m s	s	s	s
Polaris (4)	W	1. 11. 27·71	...	55·87	...
α Arietis	W	1. 59. 55·87	56·30	7·80	11·50
ξ^1 Ceti	W	2. 6. 11·24	11·20	22·75	11·55
ξ^2 Ceti	W	2. 21. 19·54	19·50	31·10	11·60
ν Ceti	E	2. 26. 8·54	7·72	19·16	11·44
ϵ Eridani	E	3. 26. 52·84	51·71	3·18	11·47
11 Tauri	E	3. 33. 7·42	7·20	18·95	11·75

Sidereal Time of Level Determination.	Level Error.
h m	"
0. 30 W	− 2·10
2. 25 W	+ 4·20
3. 21 E	+ 4·46

Adopted Collimation Error, 6"·1 (−E, + W).

Azimuth Error by Polaris and α Arietis, −26"·5 (adopted).

LATITUDE of MR. HUNTER'S STATION at SUEZ.

From the Admiralty Chart of the Port of Suez, the Latitude of the head of the Southern Mole, at the entrance of the Maritime Canal, is stated to be 29°. 56'. 3" North.

Mr. Hunter's station, near the flagstaff of the Khedivial Châlet, was 4437 yards north of this point by the said chart, corresponding to 2'. 11"·7 of latitude. Hence the Latitude of his station was—

29°. 58'. 15" North.*

DETERMINATION of the DIFFERENCE of LONGITUDE between the MOKATTAM and SUEZ STATIONS by Exchange of GALVANIC SIGNALS.

The observatories at Mokattam and Suez being in direct metallic connection, telegraphic signals were exchanged between them on the nights of 1874, Dec. 4, 5, 7, and 14.

The exchange on each night (with one unimportant exception) was conducted in the following manner:—A positive signal was sent from Mokattam every 10 seconds, for about 15 minutes, by simply pressing the key in accordance with the beat of a Solar chronometer. The movement of the galvanometer needle at Suez was recorded to the nearest tenth of a second by estimation from the Sidereal transit chronometer. A similar series of positive signals was then sent from Suez (using the Sidereal chronometer), and similarly recorded at Mokattam (by means of the Solar chronometer).

* For computing the final Equations for Suez, the latitude was assumed to be 29°. 58'. 23". N., which is sufficiently accurate.

Mokattam then sent a series of negative signals, which were followed by a negative series from Suez, the whole occupying about one hour.

From each series there could be obtained three or more comparisons of the chronometers when they were apparently beating together, but as each recorded time was correct within about one-tenth of a second, Captain Browne has preferred to take the mean of all the recorded times, the total number of which is shown in the table (page 345).

The Solar chronometer employed at Mokattam was compared with the transit-clock before and after each exchange of signals. Stars were observed at both stations on each night, as near as possible to the time of the exchange.

Captain Browne remarks that the results of the different nights are not so accordant as those obtained in the GREENWICH-MOKATTAM Longitude determination through the immense length of submarine cable, and attributes it to the fact that the instruments used at Suez for the determination and maintenance of local time were not of the high class used at Mokattam. That may be so; but there is little to complain of. Thanks to the excellence of Captain Browne's arrangements, and the consistent accuracy of Mr. Hunter's work, the Longitude of Suez must be considered to be as satisfactorily determined as that of Mokattam.

ADOPTED ERRORS and RATES of the SIDEREAL TRANSIT CHRONOMETER LOSEBY 102 on LOCAL SIDEREAL TIME at SUEZ.

Approximate Local Mean Time.	Approximate Sidereal Time.	Transit Chronometer Slow.	Loss in preceding 24^h. Sidereal.	Adopted Losing Rate.
1874. h m	h m	s	s	s
Dec. 3, 8. 16	1. 4	+ 22·70	..	..
4, 8. 16	1. 8	+ 22·35	− 0·35	− 0·68
5, 8. 14	1. 10	+ 21·325	− 1·02	− 0·64
6, 8. 19	1. 19	+ 21·075	− 0·25	− 0·65
7, 7. 16	0. 20	+ 20·06	− 1·05	− 0·94
8, 8. 21	1. 29	+ 19·19	− 0·83	− 1·08
9, 9. 0	2. 12	+ 17·81	− 1·34	− 1·00
11, 7. 52	1. 12	+ 17·18	− 0·31	− 0·21
14, 7. 24	0. 55	+ 17·12	− 0·02	− 0·71
18, 8. 53	2. 40	+ 11·55	− 1·39	− 1·39

COMPARISONS, at MOKATTAM, of the SOLAR CHRONOMETER FRODSHAM $\frac{3}{3308}$ (used for signalling with SUEZ) with the TRANSIT-CLOCK at MOKATTAM (by coincidence of beats).

Day.	Time by Frodsham $\frac{3}{3308}$. (Approx. Local Mean Time.)	Time by the Mokattam Transit-Clock.	Adopted Mokattam Transit-Clock Slow on Mokattam Sidereal Time.
1874.	h m s	h m s	s
Dec. 4	6. 57. 24·5	23. 50. 48	
	7. 0. 16·0	23. 53. 40	+ 24·79
	7. 6. 35·0	0. 0. 0	
	11. 16. 20·0	4. 10. 26	
	11. 19. 20·5	4. 13. 27	+ 24·92
	11. 22. 25·0	4. 16. 32	
Dec. 5	6. 36. 19·5	23. 33. 36	
	6. 39. 23·0	23. 36. 40	+ 25·60
	6. 48. 29·5	23. 45. 48	
	10. 40. 10·5	3. 38. 17	
	10. 43. 25·0	3. 41. 22	+ 25·73
	10. 46. 12·5	3. 44. 10	
	10. 49. 20·0	3. 47. 18	
Dec. 7	5. 52. 35·5	22. 57. 38	
	5. 55. 35·0	23. 0. 38	+ 26·95
	5. 58. 36·5	23. 3. 40	
	9. 55. 25·5	3. 1. 8	
	9. 58. 25·0	3. 4. 8	+ 27·05
	10. 1. 44·5	3. 7. 28	
	10. 4. 36·0	3. 10. 20	
Dec. 14	7. 53. 20·0	1. 26. 18	
	8. 5. 35·0	1. 38. 35	+ 31·97
	8. 8. 39·5	1. 41. 40	
	8. 14. 38·5	1. 47. 40	
	10. 1. 31·0	3. 34. 50	
	10. 4. 30·5	3. 37. 50	+ 32·02
	10. 7. 40·0	3. 41. 0	

ADOPTED HOURLY LOSING RATE of FRODSHAM $\frac{3}{3308}$ on MEAN SOLAR TIME.

	s
1874, Dec. 4	+ 0·024
5	+ 0·014
7	+ 0·053
14	+ 0·008

EXCHANGE of GALVANIC SIGNALS between MOKATTAM and SUEZ, and INFERRED DIFFERENCE of LONGITUDE.

Number of Effective Signals.	AT MOKATTAM. Mean of the Times by Frodsham $\frac{3}{3308}$ of Sending or Receiving Signals.	Sent or Received.	Mokattam Sidereal Time.	AT SUEZ. Mean of the Times by Loseby 102 of Sending or Receiving Signals.	Received or Sent.	Corresponding Suez Sidereal Time.	Suez East of Mokattam.
1874, December 4, 10^h.							
	h m s		h m s	h m s		h m s	h m s
61	9. 22. 0·000	S	2. 16. 12·10	2. 20. 56·774	R	2. 21. 19·09	0. 5. 6·99
39	9. 37. 20·727	R	2. 31. 35·35	2. 36. 20·000	S	2. 36. 42·31	0. 5. 6·96
79	10. 10. 30·000	S	3. 4. 50·09	3. 9. 34·694	R	3. 9. 56·99	0. 5. 6·90
49	10. 26. 42·500	R	3. 21. 5·25	3. 25. 50·000	S	3. 26. 12·28	0. 5. 7·03
1874, December 5, 10^h.							
81	9. 31. 30·000	S	2. 29. 40·94	2. 34. 26·515	R	2. 34. 47·80	0. 5. 6·86
58	9. 48. 30·638	R	2. 46. 44·37	2. 51. 30·000	S	2. 51. 51·28	0. 5. 6·91
73	10. 4. 40·000	S	3. 2. 56·39	3. 7. 42·086	R	3. 8. 3·36	0. 5. 6·97
47	10. 24. 4·830	R	3. 22. 24·40	3. 27. 10·000	S	3. 27. 31·26	0. 5. 6·86
1874, December 7, 9^h.							
63	8. 58. 40·000	S	2. 4. 40·17	2. 9. 26·873	R	2. 9. 46·86	0. 5. 6·69
69	9. 14. 10·579	R	2. 20. 13·31	2. 25. 0·000	S	2. 25. 19·98	0. 5. 6·67
77	9. 30. 40·000	S	2. 36. 45·45	2. 41. 32·189	R	2. 41. 52·15	0. 5. 6·70
61	9. 46. 45·148	R	2. 52. 53·26	2. 57. 40·000	S	2. 57. 59·96	0. 5. 6·70
1874, December 14, 9^h.							
79	9. 0. 50·000	S	2. 34. 31·05	2. 39. 20·877	R	2. 39. 37·95	0. 5. 6·90
53	9. 16. 46·488	R	2. 50. 30·15	2. 55. 20·000	S	2. 55. 37·06	0. 5. 6·91
87	9. 33. 30·000	S	3. 7. 16·42	3. 12. 6·434	R	3. 12. 23·49	0. 5. 7·07
57	9. 50. 0·932	R	3. 23. 50·06	3. 28. 40·000	S	3. 28. 57·04	0. 5. 6·98

We have, therefore, the following mean result for each day for the Longitude of Suez, East of Mokattam :—

	h m s
1874, Dec. 4......	0. 5. 6·970
5......	6·900
7......	6·690
14......	6·965

There does not appear to be any reason for assigning unequal weights to the above. Their mean is—

$$0^h. 5^m. 6^s{\cdot}88.$$

The corrections to be applied to this result for the relative personal equations of Captain Browne and Mr. Hunter in sending and receiving signals, and in observing transits of stars, are identical, but with sign changed, with those already described in the section *Longitude of Alexandria* (page 329), and, therefore, amount together to $+0^s{\cdot}03$. The Diurnal Aberration of the Right Ascensions of the clock stars, having been omitted by Mr. Hunter, causes the observed difference of longitude to be too small by $0^s{\cdot}02$, no clock stars being very far from the equator. The total correction is therefore $+0^s{\cdot}05$. Hence—

	h m s
CONCLUDED LONGITUDE of SUEZ, EAST of MOKATTAM	0. 5. 6·93
CONCLUDED LONGITUDE of MOKATTAM, EAST of GREENWICH	2. 5. 6·24
CONCLUDED LONGITUDE of HUNTER'S STATION at SUEZ, EAST of GREENWICH	2. 10. 13·17

G. L. T.

TRANSIT OF VENUS, 1874.

Part III.

EXPEDITION TO THE ISLAND OF RODRIGUEZ, IN THE INDIAN OCEAN,

UNDER

LIEUTENANT CHARLES B. NEATE, R.N.

SECTION I.
OBSERVATIONS AT POINT VENUS.
With Two Plates.

SECTION II.
OBSERVATIONS AT POINT COTON.
With One Plate.

SECTION III.
OBSERVATIONS AT HERMITAGE ISLET.
With One Plate.

TRANSIT OF VENUS, 1874.

PART III.

EXPEDITION TO THE ISLAND OF RODRIGUEZ.

Section 1.

OBSERVATIONS AT POINT VENUS.

With Two Plates.

TRANSIT OF VENUS, 1874.

PART III.

Expedition to the Island of Rodriguez.

SECTION I.—POINT VENUS.

Voyage and Establishment at Rodriguez.

The Government chartered steam transport *Elizabeth Martin* sailed from Woolwich, 1874, May 23, having on board the greater part of the personnel and stores of the Expeditions intended for Rodriguez and Kerguelen's Land. She arrived in Table Bay, Cape of Good Hope, June 25, where the Rodriguez detachment was reinforced by H.M.S. *Shearwater*, Commander J. W. L. Wharton, employed in surveying those coasts. Both vessels proceeded to the Mauritius, where all final arrangements were made, with the cordial co-operation of the Colonial Government. Here Lieutenant Neate placed himself in communication with Mr. Charles Meldrum, Director of the Royal Alfred Observatory, and received much valuable information in regard to the climate of Rodriguez, and especially to the hurricanes so prevalent there. Lord Lindsay's Expedition, under the charge of Mr. David Gill, arriving at Mauritius before Lieutenant Neate's departure, a plan was concerted for connecting the stations at Mauritius and Rodriguez by the transportation of Lord Lindsay's large collection of chronometers in H.M.S. *Shearwater*.*

The *Shearwater*, having on board the entire Expedition, arrived at Rodriguez August 18, and anchored at Port Mathurin.

After a thorough examination of the island, with the courteous assistance of C. Bell, Esq., the resident magistrate, a good site was selected (to be more fully described hereafter) on the ruins of an old fort, formerly called Fort Duncan, where foundations could be obtained for all the instruments on solid rock without digging, and fresh water was abundant at the distance of 300 yards.

Lieutenant Neate writes :—

"Rodriguez is an island of basaltic rock, rising somewhat abruptly from the sea, and fringed by coral reefs. A level sand-bank, varying in breadth, nearly surrounds the island, and is dry at ordinary high water. The disembarkation of the huts, instruments, and other heavy stores was necessarily a tedious operation, and could only be effected at high water. The larger and heavier cases were hoisted up to the observatory plateau by means of a

* The plan was subsequently carried out ; the *Shearwater*, starting from Mauritius, twice made the double journey with the chronometers, arriving at Rodriguez September 13 and 23. The details of these operations form no part of the present work.

pair of sheers stepped on its edge. The operations of landing and placing the instruments, huts, &c., were performed by the officers and men of H.M.S. *Shearwater*, under the superintendence of Commander Wharton.

"During the sojourn of the party on the island, observations for local time were made on every fine night; the Moon was observed both with the transit-instrument and with the Altazimuth whenever it was possible. In consequence of the cloudy weather only twelve observations of the Moon on the meridian were obtained, but on each occasion the clock and instrumental errors were very satisfactorily determined.

"The Equatorial was mounted in October, but this instrument and the secondary telescope were very little used before the transit of Venus. A few occultations of stars were observed; but little time could be spared by the observers to *watch* for these phenomena, and consequently only those occultations whose times of occurrence were known received any attention.

"The *Model* representing the appearances of the transit of Venus was mounted in November, and Commander Wharton, Lieutenant Hoggan, and myself practised with it.

"The Expedition was furnished from the Meteorological Office, Westminster, with a very complete set of Meteorological instruments. It was evident at first that to make the necessary observations and entries would occupy more time than the members of the Expedition could afford. The offer, therefore, of a local officer, Police-Sergeant Youlton, to take charge of the Meteorological observations, and to be responsible for the accuracy of the journal, was very welcome. The various instruments were read twice a day. The journal was occasionally examined by Mr. Burton or myself.*

"The transit of Venus on December 8 was observed by Commander Wharton, Lieutenant Hoggan, and myself. Their reports are appended to my own.

"The Island of Rodriguez was surveyed by the officers of the *Shearwater*, under the direction of Commander Wharton. The positions of the secondary stations on Hermitage Islet and at Point Coton depend entirely upon this survey. The difference of longitude between Point Venus and Hermitage Islet was determined by rocket signals in connection with the observations at both places for local time, but preference is given to the difference obtained geodetically.

"At my request the Colonial Government at Mauritius (to which Rodriguez

* It is deposited at the *Meteorological Office, Westminster.*

Plate XII.

Outline Chart of Rodrigues.

Shewing the positions of the three Observing Stations.

is a dependancy) undertook to protect from injury the stone building with which I enclosed the transit-hut as a protection against hurricanes, and to reserve the site for the possible use of subsequent Astronomical Expeditions.

"To conclude, it is only necessary to call attention to the extraneous work which contributed to the success of the Expedition. The most deserving of notice is the very efficient service rendered by the officers and crew of H.M.S. *Shearwater*, under Commander Wharton, already frequently mentioned, by which many great difficulties of landing and transport were overcome, involving as it often did very hard work. Without this service the work of the Expedition could not have proceeded.

"During the stay of the party at the Mauritius much assistance was rendered by various departments of the Colonial Government in the way of labour and stores; and, by arrangement between the Imperial and Colonial Governments, a dwelling-house was framed, for the residence of the Expedition at Rodriguez. A schooner was hired to carry the house to Rodriguez.

"Great attention was shown to the members of the Expedition by the officials.

"The services rendered by Mr. C. Bell and his staff of police were made the subject of a special communication to the Colonial Secretary.

"C. B. NEATE."

PERSONNEL.

The observing party at Rodriguez consisted of—

Lieutenant CHARLES B. NEATE, R.N., chief; Lieutenant R. HOGGAN, R.N.; and Mr. CHARLES E. BURTON, B.A., of Dublin, who had entire charge of the Photographic Department, and assisted in the regular astronomical observations. These observers are distinguished by the initials N, H, and B, respectively.

Three sappers of the Royal Engineers accompanied the Expedition as assistant photographers.

THE SITE AT POINT VENUS, RODRIGUEZ.

About three-quarters of a mile N.E. of the little town of Port Mathurin, on the cliff, some 50 feet above and 200 yards distant from high-water mark,

are the remains of an old fort, called on some charts *Fort Duncan.* This was the site selected, foundations on solid rock being everywhere accessible. The island, with the extensive coral formation surrounding it, was surveyed by Commander W. H. L. Wharton, R.N. and the officers of H.M.S. *Shearwater* in 1874; and on the Admiralty Chart of Rodriguez Island (Indian Ocean), published 1876, February 16, the site is named *Point Venus.*

From the Equatorial Stone the following true bearings were found:—

	° ′ ″
Apex of Booby Island	N. 74. 4. 38 W.
Apex of Diamond Island	S. 76. 11. 27 W.
Apex of Diamond Peak	S. 62. 25. 32 W.
The Beacon on the summit of Le Piton	S. 3. 24. 41 E.
Altazimuth Pier, 61 feet	S. 77 E.
Transit Pier, 84 feet	N. 46 E.
Photoheliograph Stone, 43 feet	N. 46 E.

The Transit Pier was 72 feet due North of the Altazimuth Pier.

THE TRANSIT INSTRUMENT AND CLOCK.

The *Transit instrument* and its mounting were in every respect exactly similar to those used at Honolulu (*see* page 9).

The great stone was laid upon a course of bricks, which rested upon the levelled surface of the solid rock. The instrument was fairly in the Meridian by August 31. In addition to the wooden observatory brought from England, the instrument was protected by a high stone wall, enclosing the wooden hut.

The adopted value of one revolution of the transit-micrometer-screw, which carried all five wires of the reticule, is $56''\cdot30$. It is the mean of a great number of observations of close circumpolar stars at different times. The integer revolutions of the screw were numbered in the observing books so as to increase with motion of the wires towards the screw-head; the center wire coincided approximately with the optic axis when the reading was $20^{r}\cdot4$.

The position of the transit-axis is always denoted by the record of the micrometer-screw-head being on the east or west side of the telescope.

The system of wires remained perfect during the series of observations.

The *Equatorial intervals* were found, from 400 transits of time stars, as follows:—

		″
Wire	I. (nearest to the screw-head).....	+ 429·47
,,	II. ,, ,, ...	+ 213·61
,,	III. ,, ,, ...	0·00
,,	IV. ,, ,, ...	− 212·83
,,	V. ,, ,, ...	− 424·70

The mean of the observed times of transit over the five wires is, therefore, reduced to the center wire by applying the correction $\frac{1^s \cdot 11}{15 \sin \text{N.P.D.}}$ positive with micrometer W. The quantity used by Lieut. Neate was $\frac{1^s \cdot 75}{15 \sin \text{N.P.D.}}$, and, as the instrument was habitually kept with the micrometer west, in strictness the times of true transit of all the clock stars require to be increased $0^s \cdot 04$. This minute correction, however, has no importance, except when transferred to the Altazimuth-Clock, in the reduction of the observed vertical transits of the Moon.

Collimation.—The reading of the Micrometer for coincidence of the center wire with the optic axis was found by observing temporary and fixed collimators, or close circumpolar stars, with reversed positions of the transit-axis (Tab. I.).

The *Error of Level* was found with the hanging spirit-level, two or more times each night (Tab. II.). The value of the graduations engraved on the glass bubble was re-determined by the makers before the Expedition left England. Thirty-nine divisions were equivalent to one minute of arc, which value has been used throughout.

The relative size of the pivots was examined by observing the level-error 50 times, the instrument being reversed between each two sets of five determinations. No appreciable difference could be detected.

For the *Azimuth Error* (Tab. III.) one or more of the stars in the following list were observed on the center wire, the micrometer-screw being turned as requisite to enable the star to transit the wire.

MEAN PLACES, for 1874·0, of the STARS observed at POINT VENUS for AZIMUTH ERROR, as given by MR. STONE.*

Star.	R. A. 1874·0.	N. P. D.
	h m s	° ′ ″
Lacaille 23	0. 8. 30·04	175. 41. 45·9
o Octantis	0. 12. 58·94	179. 3. 48·9
Lacaille 248	0. 39. 51·93	176. 23. 30·2
,, 634	1. 44. 54·84	175. 24. 18·4
,, 764	2. 5. 31·55	175. 21. 30·6
,, 1029	2. 39. 44·18	176. 16. 24·5
,, 1146	2. 51. 33·04	175. 32. 51·4
,, 1203	3. 3. 58·89	176. 22. 13·0
,, 1592	4. 6. 9·04	175. 37. 45·5
,, 2296	5. 54. 38·67	174. 50. 26·9
,, 2512	6. 12. 58·34	175. 55. 31·7
,, 3274	7. 30. 27·62	176. 49. 0·7
A Octantis	8. 11. 15·38	178. 29. 59·7
Brisbane 4091	12. 33. 10·45	179. 6. 26·5
z Octantis	14. 28. 50·09	177. 37. 40·9
Brisbane 5607	16. 14. 27·37	176. 7. 0·9
,, 6058	17. 40. 38·27	177. 39. 20·8
σ Octantis	18. 13. 38·63	179. 16. 39·8
B Octantis	21. 2. 14·14	179. 25. 42·2
C Octantis	22. 6. 50·20	176. 36. 17·3
τ Octantis	23. 8. 4·99	178. 10. 22·3
Lacaille 9596	23. 44. 13·05	176. 35. 49·3

The Catalogue of 78 Stars was brought up to 1874, January 1, and the logarithms of a, b, c, d and a', b', c', d' computed, before the Expeditions left England.

The *Transit clock* was originally constructed by Graham for the Royal Observatory. It was put into good order, and supplied with a cylindrical zinc-and-steel compensated pendulum by Messrs. E. Dent and Co., and tested for many months at the Royal Observatory before the departure of the Expedition from England. At Rodriguez its rate (Table V.) was not so regular as it had been during the testing at Greenwich. It was mounted upon a solid wooden tripod, resting upon the rock, and nowhere touching the floor of the observatory.

The stars observed for clock-error were taken generally from the list in use at the Royal Observatory, Greenwich. The Mean Right Ascensions have been brought up to the beginning of the year from the Greenwich Catalogue of 2760 Stars for the Epoch 1864. The reduction for the day has been taken from the *Nautical Almanac* for all stars found in that work.

The Meridional transits (Tab. IV.) have been reduced as described in

* *Places of eight close Southern Polar Stars,* Royal Observatory, Cape of Good Hope, 1874, and *Catalogue of* 78 *Stars near the South Pole,* Monthly Notices, R.A.S., XXXIII., 55.

The Meridional transits selected for publication are (1) all stars observed with the Moon on the meridian; (2) stars observed in connection with Altazimuth observations; (3) stars observed in connection with Lord Lindsay's chronometric expedition from the Mauritius. The mean determinations of the transit clock-error are given in Table V., incorporated in Table IV. The relative personal equations of the observers cannot be determined from the observations.

OBSERVATIONS OF ZENITH DISTANCE.

The Altazimuth instrument at Point Venus was exactly similar to that used at Honolulu, described in Part I., page 18. The values of the graduations on the upper and lower zenith distance levels were 30 and 25 to one minute of arc respectively.

The system of wires remained perfect throughout the observations.

No imperfect vertical transits have been used.

The Zenith Point corresponding to the Mean of the Wires was 1″·7 greater than that corresponding to the center wire.

The Mean Corrections to the reading of the vertical circle for runs of the four micrometer screws for 100″ were as follows:—

1874.		Observer.	Correction for Runs for 100″.	Number of Observations.
			″	
September	4	N	+ 0·22	4
	7	B	− 0·60	1
	8	H	+ 0·06	4
	9	B	+ 0·10	2
	11	B	+ 0·47	1
	15	N	+ 0·29	4
	24	H	+ 0·06	4
	25	B	− 0·15	4
	27	B	− 0·03	1
	28	B	− 0·15	2
October	2	B	− 0·03	2
	6	B	− 0·28	2
	19	B	+ 0·05	4
	30	N	+ 0·38	3
November	17	H	+ 0·13	4
	24	N	+ 0·10	3
December	7	B	− 0·21	2
	10	B	− 0·25	2

On November 13 the object-glass of microscope B, with its cell, was discovered to be broken away from the body of the microscope. It was effectively repaired with cement. The observations of November 12 and 13 have, in consequence, been rejected. An examination of the differences of the means of opposite microscopes, before and after November 13, seems to show that the accident was discovered soon after it occurred.

A mercurial barometer, by Messrs. Horne and Thornthwaite, which had been tested at Greenwich and found to have no appreciable error, was suspended inside the Altazimuth hut. A verified thermometer was placed outside on the S.W. side. The thermometer attached to the barometer generally read 3° higher than the external thermometer; but it cannot be thence inferred that the temperature within the hut was higher to that extent than the external temperature, the attached thermometer not having been verified.

Satisfactory comparisons of the Altazimuth Clock, Dent 2014, with the Transit Clock, Graham 2, were made on 56 days.

The LATITUDE of the ALTAZIMUTH PIER.

Numerous observations for co-latitude were made on 42 days, on stars very near to the meridian, at zenith distances from 10° to 65°; in one instance at 75°. The mean results are—

					° ′ ″
From 59 stars		North of the Zenith,	Co-latitude	=	70. 19. 38·2 S.
„ 28	„	South	„	„	70. 19. 37·6

The declinations of the northern stars depend upon observations at Greenwich; those of the southern stars upon observations at Melbourne and at the Cape of Good Hope.

The adopted latitude of the Altazimuth pier is 19°. 40′. 22″·1 S.

On the LONGITUDE of POINT VENUS.

(1.) *From the Observations of the Moon on the Meridian.*

The observations have been reduced as described in Part I., page 22. The results for longitude are exhibited in the usual form in Table VI., from which are obtained the following means:—

Observer.	☽ I.	Number of Obs.	☽ II.	Number of Obs.	Mean Longitude.
	s		s		h m s
B	43·25	4	42·02	4	4. 13. 42·63
H	39·88	5	46·35	4	4. 13. 43·11
N	37·40	1	43·77	4	4. 13. 40·59
	MEAN, POINT VENUS EAST of GREENWICH..........				4. 13. 42·11

(2.) *Longitude of Point Venus, from the observed Zenith Distances of the Moon.*

Rodriguez is not very favorably situated for the application of this method in the autumn months, the ecliptic being far from perpendicular to the horizon at the times at which the Moon can be observed, and difficulty was experienced in obtaining a sufficient number of observations of the Moon's second limb.

The method of comparing the Altazimuth Clock with the Transit Clock, and of making and of reducing the Zenith Distance Observations, have been described in the Honolulu section. The corrections to the Moon's Tabular R. A. and N. P. D. were taken from the *Appendix*.

It was not the general practice at Point Venus to observe the vertical transit of a star near the Moon. The time, determined by one observer with the Transit instrument, was transferred to the Altazimuth Clock, and was used by another observer. 178 zenith-distance observations were made on 28 days. For each observation, the Tabular Zenith Distance was computed from the Nautical Almanac with corrected elements (as explained in the *Appendix*) on the two assumptions of longitude $4^h. 13^m. 10^s.$ and $4^h. 14^m. 0^s.$ East of Greenwich. The comparison of these gave a longitude of the station. An abstract of these results is given in Table VII.

The differences between the Observed and the Tabular Zenith Distances of the stars observed in vertical transit are collected in the following table. The series is sufficiently numerous as regards the comparison of times deduced from Mr. Burton's Altazimuth Observations with times given by Lieutenant Neate's Transit Observations, and shows a large systematic discordance.

There is some slight evidence of a similar discordance of opposite sign between Lieutenant Neate with the Altazimuth and Lieutenant Hoggan with the Transit; but, neglecting the single comparison on October 2, there are no observations for estimating the amount of the discordance for the other four combinations of observers and instruments. It is somewhat singular, in view of the certainty of the existence of these systematic errors, that the mean longitude by Altazimuth should be so very near to the mean by the Transit instrument.

COMPARISON of the OBSERVED and TABULAR ZENITH DISTANCES of STARS OBSERVED in VERTICAL TRANSIT with the ALTAZIMUTH at POINT VENUS.

1874.		Star.	East or West of Meridian.	Excess of the Tabular Z. D. (with Sign changed for Stars East).	Altazimuth Observer.	Transit Observer.
				″		
September	14	α Libræ	W	− 5·7	B	N
	17	α Scorpii	W	+ 1·2	B	N
October	2	Sirius	E	− 0·4	B	H
	16	δ Sagittarii (Lamp R only)	W	(− 1·4)*	B	N
November	23	Procyon	E	+ 2·6	N	H
	25	α, γ Leonis	E	+ 5·3	N	H
December	3	Procyon	E	− 2·3	B	N
		ε Canis Majoris	E	− 2·6	B	N
		β Arietis	W	− 2·9	B	N
		ζ¹ Orionis	W	− 1·8	B	N
	5	δ Orionis (Lamp L only)	E	(− 7·1)*	B	N
		β Canis Majoris	E	− 7·2	B	N
		β Ceti	W	− 5·3	B	N
		γ Pegasi	W	− 8·7	B	N
	7	κ Orionis	E	− 4·4	B	N
		δ Orionis	E	− 6·2	B	N
		β Ceti	W	− 3·5	B	N
		γ Pegasi	W	− 6·9	B	N
	8	α Pegasi	W	− 3·2	B	N
		δ Aquarii	W	− 2·6	B	N
		β Ceti	W	− 3·5	B	N
		β Canis Majoris	E	− 4·7	B	N
		β Canis Minoris	E	− 5·6	B	N
		α Hydræ	E	− 6·7	B	N
	9	ε Canis Majoris	E	− 5·0	B	N
		β Ceti	W	− 6·3	B	N
		β Canis Majoris	E	− 5·9	B	N
		β Canis Minoris	E	− 7·5	B	N
		η Ceti	W	− 1·2	B	N

* October 16, δ Sagittarii. Lamp Left gives −25″·8; December 5, δ Orionis, Lamp Right, gives +22″·3.

[The mass of calculations connected with the Altazimuth observations is so great, and the complete examination of any one by any future investigator so improbable, that I determined to withdraw from publication all except the results. The calculations had been most severely checked by Major Tupman, and the manuscripts are preserved at the Royal Observatory.—G. B. A.]

The following are the results for the longitude deduced from the observed Zenith Distances of the Moon, corrected for the constant error of $0^s{\cdot}04$ in the Sidereal time as described on page 355.

Observer.	☽ I.	Number of Days of Observation.	☽ II.	Number of Days of Observation.	Mean Longitude.
	s		s		h m s
N	42·45	10	32·79	4	4. 13. 37·62
H	49·27	12	41·24	3	4. 13. 45·26
B	49·02	7	43·53	3	4. 13. 46·27

MEAN, POINT VENUS EAST of GREENWICH .... 4. 13. 43·05

(3.) *Longitude of Point Venus from Occultations of Stars by the Moon.*

For the reduction of the occultations, the corrections to the Tabular Geocentric place of the Moon's center have been taken as follows:—

	Correction to R.A.	Correction to N.P.D.
	s	″
1874, October 14,	− 0·30	− 2·2
15,	− 0·30	0·0
17,	− 0·33	+ 0·8
November 12,	− 0·40	+ 2·0
16,	− 0·31	+ 3·5

The calculations have been made as described on page 27, including the constant reduction of 2″·00 of Tabular Semidiameter.

COMPARISON of CLOCKS and CHRONOMETERS in connection with the OBSERVED OCCULTATIONS.

Approximate Local Mean Solar Time.	Observer.	Name of the Solar Chronometer employed.	Time by Transit-Clock at comparison with Chronometer.	Time by Chronometer: At comparison with Transit Clock.	Time by Chronometer: At comparison with Equatorial Clock.	Time by Equatorial Clock at comparison with Chronometer.
1874. d h			h m s	h m s	h m s	h m s
Oct. 14. 4	B	Barraud......	18. 16. 44·0	12. 5. 24·5	11. 56. 9·5	18. 3. 41·0
8	N	Carter	21. 45. 1·0	3. 1. 5·0	2. 47. 30·0	21. 27. 34·0
Oct. 15. 4	B	Barraud......	17. 58. 53·0	11. 43. 41·5	11. 37. 45·5	17. 48. 57·0
8	B	Barraud......	21. 49. 4·0	3. 33. 15·0		
8	H	Parkinson and Frodsham	21. 54. 50·0	8. 11. 24·8		

Approximate Local Mean Solar Time.	Observer.	Name of the Solar Chronometer employed.	Time by Transit-Clock at comparison with Chronometer.	Time by Chronometer		Time by Equatorial Clock at comparison with Chronometer.
				At comparison with Transit Clock.	At comparison with Equatorial Clock.	
1874. d h			h m s	h m s	h m s	h m s
Oct. 16. 3	N	Parkinson and Frodsham	16. 52. 17·0	3. 5. 50·4		
8	B	Carter	21. 32. 14·0	2. 40. 29·5		
Oct. 17. 8	N	Carter	21. 56. 17·0	3. 0. 32·5	2. 52. 49·5	21. 44. 7·0
8	H	Barraud*.....	21. 58. 25·0	8. 19. 45·0		
8	N	Barraud......	22. 11. 35·0	8. 32. 53·0		
Oct. 18. 10	B	Carter	23. 59. 36·0	4. 59. 35·5		
10	N	Barraud......	0. 1. 35·0	10. 18. 40·5	10. 22. 39·5	0. 0. 56·0
Nov. 11. 12	N	Hewitt.......	3. 12. 23·0	11. 44. 0·5	11. 58. 19·0	3. 23. 46·0
Nov. 12. 10	N	Barraud......	1. 50. 34·0	10. 28. 25·5	10. 33. 45·0	1. 52. 41·0
Nov. 13. 12	N	Barraud......	2. 15. 39·0	10. 49. 30·0	12. 8. 36·5	3. 31. 27·0
Nov. 15. 10	B	Carter	2. 5. 44·0	5. 13. 50·5		
13	N	Barraud......	2. 7. 21·0	10. 33. 20·5	12. 44. 35·5	4. 14. 52·0
Nov. 16. 8	B	Carter	——	——	2. 38. 30·0	23. 29. 38·0
10	B	Carter	——	——	4. 54. 0·0	1. 45. 29·0
12	N	Carter	4. 3. 21·0	7. 7. 9·5	6. 52. 35·5	3. 44. 23·0†
Nov. 17. 9	B	Carter	0. 13. 45·0	3. 13. 10·5		
9	N	Barraud......	0. 45. 14·0	9. 3. 34·5	8. 53. 3·0	0. 30. 5·0‡
Nov. 18. 13	N	Barraud......	4. 43. 27·0	12. 57. 10·5	13. 25. 10·5	5. 6. 34·0

* Barraud had been recently advanced 4^h.
† Increased 10^s.
‡ Error of 1^s. in the comparison with the Equatorial Clock.

OCCULTATIONS of FIXED STARS by the MOON observed at POINT VENUS.

[All are disappearances at the Moon's Dark Limb.]

1874.	Observer.	Telescope.	Star.	Name of Chronometer or Clock.	Recorded Time of Disappearance.	Correction to Chronometer or Clock.	Local Mean Solar Time.	No.
					h m s	h m s	h m s	
Oct. 14	B	12-inch Reflector..	Ö. A. 15521	Equatorial Clock, Sidereal	21. 22. 25·8	+ 0. 4. 16·22	7. 54. 38·68	1
Oct. 15	B	12-inch Reflector..	29 Scorpii	Barraud, Solar	3. 26. 7·3	+ 4. 40. 16·53	8. 6. 23·83	2
	H	4-inch Achromatic.	"	Parkinson and Frodsham, Solar.......	7. 58. 32·1	+ 0. 7. 51·79	8. 6. 23·89	2
Oct. 17	N	6-inch Equatorial.	τ Sagittarii	Equatorial Clock, Sidereal	21. 41. 37·5	+ 0. 5. 0·85	8. 2. 44·02	3
	B	12-inch Reflector..	"	Carter, Solar	2. 50. 21·2	+ 5. 12. 23·61	8. 2. 44·81	3
	H	4-inch Achromatic.	"	Barraud, Solar	8. 7. 26·8	− 0. 4. 41·21	8. 2. 45·59	3
Nov. 12	B	?	Yarnall 7470 (mag. 9)	Equatorial Clock?	22. 18. 50·2	+ 0. 3. 38·92	6. 56. 15·27	4
Nov. 16	H	4-inch Achromatic	Lalande 42064.....	Transit Clock	23. 31. 4·8	+ 0. 0. 30·36	7. 49. 26·34	5
	N	6-inch Equatorial.	"	Equatorial Clock, Sidereal	23. 26. 46·1	+ 0. 4. 49·06	7. 49. 26·34	5
	B	12-inch Reflector..	"	Carter, Solar	2. 35. 38·2	+ 5. 13. 47·81	7. 49. 26·01	5
Nov. 16	B	12-inch Reflector.	"A Double Star" (both components)	Carter, Solar	4. (36.) 39·1 43·2	+ 5. 13. 48·22	9. (50.) 27·32 31·42	6
	N	6-inch Equatorial.	"A Double Star"..	Equatorial Clock, Sidereal	1. 30. 13·8	+ 0. 4. 50·63	9. 52. 35·39	6

October 15. The star was recorded by B as 38 Ophiuchi, mag. 6½; by H as A Ophiuchi, mag. 5. Both observers state that it was very near to the Moon's North Limb.

October 17. B remarks, "through thin cloud."

November 12. The only record of this occultation is as follows, in Mr. Burton's handwriting:—"November 12. Occultation of .... $22^h. 18^m. 50^s.2$, dark limb; instantaneous." The record of 22^h. shows that a *clock* was probably used for the observation. The 9 mag. star, Yarnall 7470, was undoubtedly occulted at $22^h. 22^m. 29^s$. sidereal, very nearly, and there being no other known star in the neighbourhood it has been assumed that the record is that of an occultation of Yarnall 7470, the time being taken from the Equatorial Clock.

November 16. The star assumed to be Lalande 42064 was entered "Anonymous, 7 mag." by all three observers. The "Double Star" was entered 8 mag. ± by both observers. The 9 mag. star, No. 29, of Washington Transit Zone 181, was occulted about $9^h. 52^m. 35^s$. mean solar time. Mr. Burton suspected that the minutes he recorded should have been 38 instead of 36.

CALCULATION of the LONGITUDE of POINT VENUS, RODRIGUEZ, from the observed OCCULTATIONS.

Approximate Local Mean Time.	Star.	Greenwich Mean Time on two assumptions of Longitude. a. = 4. 13. 32·0 E. b. = 4. 13. 52·0 E.	Tabular Apparent Place of Moon's Center (corrected for Errors of Tables). R. A.	Tabular Apparent Place of Moon's Center (corrected for Errors of Tables). N. P. D.	Moon's Augmented Semi-diameter (corrected).	Apparent R. A. of Star.	Apparent N. P. D. of Star.	Authority for Place of Star.	Inferred Longitude East of Greenwich.	—
1874. d h m		h m s	h m s	° ′ ″	″	h m s	° ′ ″		h m s	
Oct. 14. 7. 55	Ö. A. 15521.	a. 3. 41. 6·68 b. 40. 46·68	16. 12. 32·43 31·72	114. 34. 7·5 4·9	893·40					
Oct. 15. 8. 6	29 Scorpii.	a. 3. 52. 51·89 b. 31·89	17. 5. 37·29 36·54	117. 0. 40·8 39·2	902·30	17. 6. 24·89	116. 50. 4·3	Dr. Gould; Cordoba Zone Obs.	4. 13. 42·0	Unfavorable.
Oct. 17. 8. 3	τ Sagittarii.	a. 3. 49. 12·80 b. 48. 52·80	18. 58. 1·25 0·45	117. 56. 35·4 36·3	926·95	18. 59. 6·46	117. 51. 14·8	Gr. 9-yr. (1872).	4. 13. 41·6	Favorable.
Nov. 12. 6. 56	Yarnall 7470.	a. 2. 42. 43·24 b. 23·24	17. 44. 30·21 29·43	117. 52. 57·9 57·2	905·28	17. 45. 25·49	118. 1. 38·4	Dr. Gould; Cordoba Mer. Obs.	4. 13. 44·5	Favorable.
Nov. 16. 7. 49	Lalande 42064.	a. 3. 35. 54·23 b. 34·29	21. 29. 31·47 30·70	109. 44. 38·6 42·6	953·20	21. 30. 37·43	109. 47. 38·2	Lalande 42064, Lamont 1430, Dr. Gould; Cordoba Mer. Obs.	4. 13. 42·0	Favorable.
Nov. 16. 9. 52	"Anonymous Double Star."	a. 5. 39. 3·39 b. 38. 43·39	21. 32. 39·04 38·30	109. 13. 27·0 30·9	948·69					

SUMMARY OF LONGITUDE OF POINT VENUS.

	h. m. s.
By the Meridional Transits of the Moon	4. 13. 42·11
By the Zenith Distances................................	4. 13. 43·05
By the Occultations of Stars	4. 13. 42·52

The preliminary longitude of Point Venus, Rodriguez, obtained by Lord Lindsay, by the transportation of 42 chronometers between that station and his observatory at Belmont, Mauritius, is—

$$4^h. 13^m. 43^s\cdot 0.$$

In this determination the longitude of SUEZ and ADEN were determined by telegraph signals (that of Suez being given in Part II., Section 3), and the chronometers were transported from Suez to Mauritius before the transit of Venus, and from Mauritius to Aden after the transit. These long sea voyages are fatal to the accurate measurement of Meridian distances by chronometers; it is nevertheless highly satisfactory to find such close agreements as the above.

The final longitude of Point Venus may be assumed to be—

$$4^h. 13^m. 42^s\cdot 5 \pm 1^s\cdot 0.$$

In computing the final Equations derived from the observations of the Ingress and Egress of Venus, 1874, December 8, the Longitude of the Head Station at Point Venus was assumed to be $4^h. 13^m. 43^s\cdot 0$. Hence the error of the Greenwich Sidereal Time is $\delta t = + 0^s\cdot 5$.

G. L. T.

OBSERVATIONS OF THE TRANSIT AT POINT VENUS.

NEATE'S OBSERVATIONS OF INGRESS.

The instrument used by Lieutenant Neate was an Equatoreal, with object glass of 6 inches aperture, driven by clock-work, constructed for the expedition by Messrs. Troughton and Simms. It was fitted with double-image micrometer and solar diagonal reflector, as represented in Plate III. The equatoreal mounting was supported by an iron pillar, which at Rodriguez stood upon a foundation of brickwork laid on the rock. It was protected by a portable wooden observatory, constructed at Greenwich. A sidereal clock

(Dent 2014), with pendulum rod of wood, accompanied the instrument, and was mounted in the Equatoreal hut.

The following is Lieutenant Neate's Report of the observations.

OBSERVATIONS OF INGRESS.

For several days previous to the transit I practised observing the Sun with the Equatoreal, and established the focal adjustment as accurately as I could. On two mornings also I observed the Sun under conditions exactly similar to those which I anticipated for the actual transit. On the morning of December 9, a little before sunrise, I prepared the Equatoreal hut, tried all the eye-pieces and double-image micrometer in the instrument, tested the driving clocks for the last time, and assured myself generally that all was ready. By the kind permission of Mr. Bell, the resident magistrate, the observatory was surrounded by policemen, and no one was allowed to approach. My assistant on the occasion was Navigating Lieutenant Hammond, of H.M.S. *Shearwater*, who sat at a table in the Equatoreal hut, and wrote from my dictation in copying ink.

Half an hour before the first phenomenon I compared the Equatorial Clock with the Transit Clock.

The sky was unusually clear of clouds, and the heat of the Sun made itself felt very soon.

I did not see the planet till it had (apparently) broken into the Sun's limb. Instantly when I saw the notch on the Sun's limb I also saw the remaining segment of the planet showing in strong relief against the dark space beyond, and surrounded by an *exceedingly* faint annular haze. The following limb of the planet also appeared bright, like a very young moon. This appearance I have attempted to show in Fig. 1, Plate XIII. I used an Airy eye-piece, power 152, for the observation of all phenomena. The dark glass I used was a neutral tint achromatised wedge. The first phenomenon recorded by me was that of Circular or apparent Contact at $11^h. 51^m. 24^s{\cdot}5$ by the Equatorial Clock, as shown in Fig. 2. The formation of a dark ligament between the limbs of the Sun and Venus followed instantaneously. It was as if, after Circular Contact, a piece of Venus was being drawn out by the Sun.

The breadth of this ligament was apparently one-fourth (approximately) of Venus' diameter.

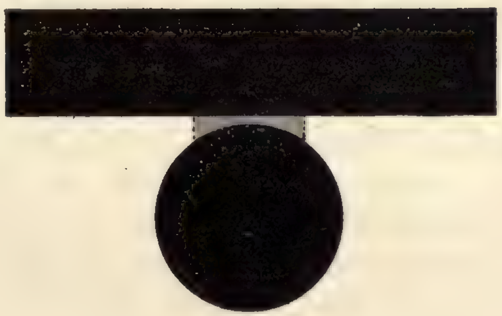
The next phenomenon noted by me was the change of colour in the ligament, which at $11^h. 51^m. 51^s{\cdot}5$ became a light-greyish brown. The change

Transit of Venus 1874 Dec. 8.

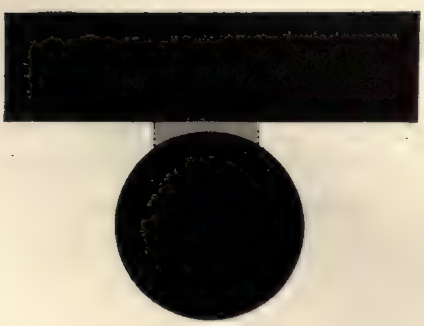
Observations at Point Venus, Rodriguez by Lieutenant Neate, R.N. with a Telescope of 6 inches aperture power 152.

Ingress, Fig. 1.

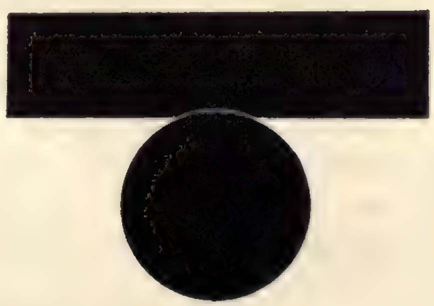
Ingress, Fig. 2.



Ingress Fig 3.



Egress, Fig. 1.



Egress, Fig. 2.

Dangerfield. Lith. 22. Bedford St. Covent Garden.

was apparently very rapid and well-defined. I have noted it to a fraction of a second. In Fig. 3 I have attempted to show this second phenomenon noted by me, but the ligament appears broader than it should be. The definition during these phenomena was exceedingly good, but the conditions changed very rapidly, and the Sun's limb began to boil considerably, so much so that, although I placed the double-image micrometer in the telescope as soon as the planet had left the Sun's limb, I only secured two measurements of distances of limbs, which are not recorded here, as the definition of the planet was extremely bad, and the micrometer-zero was uncertain. I, however, noticed that the following limb of the planet was apparently illumined, partaking somewhat of the appearance it had when outside the Sun; this lasted for nearly five minutes after the planet had completely entered on the Sun.

I now proceeded to compare the Equatorial and Transit Clocks. I also compared the Transit and Altazimuth Clocks. The heat in the Equatoreal hut very soon became so great that I was unable to sit at the telescope, the Thermometer in the hut (but shaded) standing at 115° Fahrenheit. I was very nearly having a sunstroke, and was obliged to lie down for an hour. Shortly before the phenomenon of Egress I again compared the Transit, Equatorial, and Altazimuth Clocks, and then placed myself at the telescope. The definition was now bad, the atmosphere appearing very disturbed; but about ten minutes before the second Internal Contact a big cloud passed across the Sun, and slightly cooled the atmosphere, and the definition was improved. The proximity of clouds, however, deterred me from using the double-image micrometer for measuring distances of limbs; nothing, however, interfered with my observations of Contact and accompanying phenomena.

The first phenomenon noticed by me at Egress was the formation of a brown haze between the two limbs; and in spite of the apparent dancing of the limb of Venus and the boiling of the Sun's limb, this formation appeared instantaneously at $15^{h}. 21^{m}. 27^{s}\cdot2$, and in appearance it resembled closely what I had seen at Ingress in the second noted phenomenon. In Fig. 1 at Egress I seemed to see a repetition of Fig. 3 at Ingress, with the difference of inferior definition at Egress. The ligament gradually deepened in colour (maintaining the same breadth) till Internal Contact (Fig. 2, Egress) was formed at $15^{h}. 22^{m}. 24^{s}\cdot8$. This phenomenon was fairly well-defined, although

not so well as the first Internal Contact had been. I was, however, enabled to note it to the fraction of a second.

I now put in the double-image micrometer, intending to make measurements of cusps; but clouds prevented my making more than two measurements. I, therefore, replaced the Airy eye-piece, and I was fortunate enough to catch sight of the planet about three minutes before it disappeared; and the last phenomenon I noted was the disappearance of the little black notch in the straightening of the Sun's limb at $15^h. 50^m. 28^s \cdot 0$, and immediately afterwards I compared the three clocks as before. On the planet leaving the Sun I failed entirely to see what I had seen at Ingress, namely, the preceding limb on the external segment of the planet projected against the dark space beyond. With reference to the dark ligament, to which I have alluded, I may mention that at no time did it appear *perfectly* black; even immediately succeeding and immediately preceding the first and second Internal Contacts respectively it was a degree less dark than the planet. In this particular it differed from that which, according to my impression, the "Model" phenomena showed. During "Mid-transit" I examined the planet with various eye-piece powers, and it appeared to me to have a *very* slight ellipticity, the greatest diameter being inclined about 30° to the path of the planet.

COMPARISONS of the EQUATORIAL CLOCK MOLYNEUX with the TRANSIT CLOCK GRAHAM 2, by the intervention of the SOLAR CHRONOMETER CARTER 410.

Day and Approximate Local Mean Solar Time.	Time by Transit Clock at comparison with Chronometer.	Time by Chronometer at comparison		Time by *Molyneux* at comparison with Chronometer.	Inferred *Molyneux* Slow on Local Sidereal Time.	Adopted Hourly Losing Rate of *Molyneux*.
		With Transit Clock.	With *Molyneux*.			
1874.						
h	h m s	h m s	h m s	h m s	m s	s
Dec. 8, 12	4. 45. 13·0	6. 19. 55·0	7. 19. 10·0	5. 44. 8·0	+ 0. 53·56	
18	10. 44. 9·0	0. 17. 50·5	0. 19. 58·0	10. 45. 45·0	0. 55·19	+ 0·310
19	12. 6. 33·0	1. 40. 0·5	1. 44. 16·0	12. 10. 17·0	0. 55·51	
23	16. 0. 37·0	5. 33. 24·5	5. 30. 24·5	15. 57. 13·0	+ 0. 46·69*	

* An error of 10s. in one of the readings.

The chronometer Carter was losing $7^s \cdot 5$ daily on mean solar time.

From Lieutenant Neate's telescopic observations we obtain the following results:—

Assuming Latitude 19°. 40′. 21″·4; Longitude 4^h. 13^m. 43^s·0 East.

Phenomena Observed.	Recorded Time.	Local Sidereal Time.	Greenwich Sidereal Time.	Local Tabular Distance of Centers.
INTERNAL CONTACT at INGRESS.				
	h m s	h m s	h m s	′ ″
Circular contact	11. 51. 24·5	11. 52. 19·92	7. 38. 36·91	15. 39·60
Change of colour of ligament	11. 51. 51·5	11. 52. 46·92	7. 39. 3·91	15. 38·75
Disappearance of ligament.........	11. 52. 14·8	11. 53. 10·23	7. 39. 27·22	15. 38·00
INTERNAL CONTACT at EGRESS.				
Formation of ligament............	15. 21. 27·2	15. 22. 22·7	11. 8. 39·7	15. 41·27
Apparent contact	15. 22. 44·8	15. 23. 40·3	11. 9. 57·3	15. 43·81
EXTERNAL CONTACT at EGRESS.				
Disappearance of the planet........	15. 20. 28·0	15. 51. 24·65	11. 37. 41·64	16. 43·78

For the "disappearance of the ligament" at Ingress, taking R = 976″·80, r = 31″·42, we have the equation—

$$+ 7''\cdot 38 = +''\cdot 1937\, n - \cdot 6103\, \delta\, \text{R.A.} - \cdot 7498\, \delta\, \text{N.P.D.} - 0''\cdot 0306\, \delta t - \delta \text{R} + \delta r.$$

For the "formation of the ligament" at Egress, taking R = 976″·82, r = 31″·42, we have—

$$+4''\cdot 13 = -''\cdot 0274\, n - \cdot 2176\, \delta\, \text{R.A.} - \cdot 9718\, \delta\, \text{N.P.D.} + 0''\cdot 0322\, \delta t - \delta \text{R} + \delta r.$$

The final longitude being 0^s·5 further East than that adopted in computing the Greenwich Sidereal times above, a correction is required to these equations, which is obtained by making $\delta t = + 0^s\cdot 5$.

δ R.A. is expressed in seconds of arc.

G. L. T.

OBSERVATIONS

AT

POINT VENUS, RODRIGUEZ,

IN TABULAR ARRANGEMENT.

TABLE I.—COLLIMATION of the TRANSIT INSTRUMENT at POINT VENUS.

Day.		Object.	Reading of Micrometer for Zero of Collimation. Observed.	Adopted.
1874.			r	r
Sept.	1	Collimator.........	20·389	20·389
	1	Reflected Wires....	20·389	
	12	Collimator.........	20·381	20·380
	18	σ Octantis.........	20·385	20·380
	18	Collimator.........	20·377	
	19	Collimator	20·402	20·380
	21	Collimator.........	20·384	20·380
	21	Collimator.........	20·377	
	22	Collimator.........	20·385	20·384
	22	τ Octantis.........	20·374	
	25	c Octantis.........	20·392	20·380
	25	τ Octantis.........	20·388	
Oct.	19	Collimator.........	20·382	20·380
	24	o Octantis.........	20·372	20·380
Oct.	26	Lacaille 634	20·378	20·380
	26	z Octantis.........	20·376	
	27	Lacaille 1029	20·398	20·380
	27	Lacaille 1203	20·327	
	30	Collimator.........	20·379	20·380
Nov.	16	Lacaille 1592.......	20·395	20·370
	24	Collimator.........	20·398	20·390
	27	Collimator.........	20·389	20·390
	28	Lacaille 3274	20·376	20·390
Dec.	7	Lacaille 1592	20·370	20·385
	7	Collimator.........	20·386	
	8	z Octantis.........	20·400	20·383
	8	Collimator.........	20·383	
	10	Collimator.........	20·393	20·388

TABLE II.—ERROR OF LEVEL of the TRANSIT INSTRUMENT at POINT VENUS, determined by SPIRIT LEVEL.

[The sign + indicates that the East Pivot was low.]

Day.		Sidereal Time of Level Determination.	Error of Level.
1874.		h m	″
September	1	20. 0	+ 0·9
		21.45	+ 2·0
		2.15	+ 3·5
		2.45	+ 2·6
		3.26	+ 3·3
	2	0. 0	+ 1·6
	13	16.27	+ 6·3
		17. 5	+ 6·9
	19	18.30	− 4·3
		19.34	− 3·0
		19.55	− 2·9
	21	18.15	− 2·8
		20.30	− 1·2
		22.18	− 0·2
		22.40	− 0·7
		23.30	+ 0·1
1874.		h m	″
September	22	19.33	− 1·0
		19.55	+ 0·2
		20.23	+ 0·2
		21.23	− 0·4
		23.25	+ 0·7
		0.20	− 0·1
	23	20. 5	− 1·1
		21.55	− 0·1
		23.15	+ 1·5
		0.35	+ 1·1
		1.30	+ 1·8
		2.30	+ 1·1
October	1	5.57	− 0·4
		6.28	0·0
		7. 0	0·0
		7.40	− 0·9

Table II.—Error of Level of the Transit Instrument at Point Venus—*concluded*.

Day.		Sidereal Time of Level Determination.	Error of Level.
1874.		h m	″
October	20	21. 50	− 0·9
		0. 40	0·0
	23	23. 30	− 1·0
		0. 35	+ 0·2
	24	23. 3	+ 0·2
		0. 30	+ 1·3
		1. 39	+ 1·7
	25	0. 20	+ 1·0
		2. 30	+ 2·2
	26	0. 40	− 0·2
		1. 32	+ 0·7
		1. 55	+ 1·3
		2. 40	− 0·2
		3. 25	+ 2·1
		3. 35	+ 1·9
	27	2. 45	0·0
		3. 15	+ 0·5
		3. 45	+ 1·6
		4. 53	+ 1·9
	28	5. 0	− 0·1
	29	2. 10	+ 0·2
		6. 52	+ 0·7
November	16	21. 30	+ 2·5
		0. 50	+ 3·4
		4. 10	+ 4·7
	23	4. 5	+ 10·9
		5. 50	+ 13·0
		7. 30	+ 13·8
1874.		h m	″
November	24	4. 25	+ 2·6
		5. 45	+ 3·8
		6. 35	+ 4·2
	25	4. 0	+ 5·3
		6. 20	+ 7·1
		6. 25	+ 5·6
	28	6. 25	+ 3·2
		7. 40	+ 4·3
		8. 35	+ 5·2
		9. 30	+ 5·2
December	7	2. 0	− 0·6
		3. 41	+ 1·5
		4. 17	0·0
		4. 35	+ 1·0
		5. 35	+ 1·2
	8	1. 50	0·0
		3. 40	+ 1·1
		4. 20	+ 1·5
		5. 20	+ 2·4
		5. 50	+ 1·9
	9	1. 50	+ 0·9
		3. 0	+ 2·7
		4. 30	+ 2·7
		5. 25	+ 3·6

TABLE III.—AZIMUTH ERROR of the TRANSIT INSTRUMENT at POINT VENUS.

[The Sign + signifies that the Optic Axis points East of North.]

Day.		Stars.	Azimuth Error.	
			Observed.	Adopted.
1874.			″	″
September	1	z Octantis S.P. and δ Arietis	+ 61·3	+ 61·3
	2	τ Octantis and ω Piscium	+ 59·4	+ 59·4
	13	Least Squares	+ 14·2	+ 16·8
	19	A Octantis S.P. and β^1 Lyræ	− 2·8	− 8·8
		B Octantis and β Aquilæ	− 11·0	

Table III.—Azimuth Error of the Transit Instrument at Point Venus—*concluded.*

Day.		Stars.	Azimuth Error. Observed.	Azimuth Error. Adopted.
1874.			″	″
September	21	A Octantis S.P. and α Cygni	− 5·9	− 5·1
		B Octantis and ϵ Pegasi	− 4·8	
		C Octantis and ζ Pegasi	− 6·6	
	22	A Octantis S.P. and B Octantis	− 4·1	− 4·1
		C Octantis and η Aquarii	− 2·4	
		τ Octantis and κ Piscium	− 4·0	
	23	B Octantis and α Cygni	− 6·2	− 2·1
		o Octantis and 26 Ceti	− 2·1	
	25	C Octantis and α Aquarii	− 1·1	− 0·9
		τ Octantis and ι Piscium	− 0·8	
October	1	σ Octantis S.P. and Sirius	− 2·0	− 2·0
	20	C Octantis and λ Aquarii	− 6·4	− 2·5
		τ Octantis and α Pegasi	− 2·9	
		o Octantis and β Ceti	− 2·5	
	23	o Octantis and μ Andromedæ	− 1·9	− 1·7
		z Octantis S.P. and Lacaille 634	− 1·4	
	24	τ Octantis and κ Piscium	− 0·8	− 0·2
		o Octantis and α Andromedæ	+ 0·4	
	25	o Octantis and 20 Ceti	− 3·8	− 3·8
	26	*z* Octantis S.P. and Lacaille 634	+ 1·4	+ 1·4
	27	Lacaille 1029 and *f* Tauri	+ 2·8	+ 3·0
		Lacaille 1203 and ϵ Eridani	+ 3·3	
	28	Lacaille 1203 and ϵ Eridani	+ 3·3	+ 2·4
	29	Lacaille 1146 and σ Arietis	+ 2·6	+ 1·8
		Lacaille 1203 and o Tauri	+ 1·5	
		Lacaille 1592 and ϵ Tauri	+ 1·9	
November	16	Lacaille 248 and γ^1 Eridani	− 6·6	− 6·4
		Lacaille 1592 and 37 Tauri	− 6·3	
	23	Brisbane 6058 S.P. and Lacaille 2512	−50·8	−50·0
		σ Octantis S.P. and Lacaille 2512	−49·3	
	24	Lacaille 2296 and ϵ Orionis	−54·0	−54·9
		Lacaille 2512 and α Orionis	−55·9	
	25	Least Squares	−61·7	−59·3
	28	Lacaille 3274 and η Cancri	− 8·4	− 8·4
December	7	Lacaille 764 and *z* Octantis S.P.	− 4·6	− 4·6
		Lacaille 1592 and *s* Tauri	− 5·2	
	8	Lacaille 634 and *z* Octantis S.P.	− 4·9	− 4·8
		Lacaille 1592 and α Tauri	− 4·0	
	9	Lacaille 634 and ξ^2 Ceti	− 4·8	− 5·3
		Lacaille 1146 and Brisbane 5607 S.P.	− 4·8	

In the instances marked "Least Squares" Clock-Errors have been formed by use of all the Clock-Stars observed in the day, each containing the Azimuthal Error as an unknown quantity; and the magnitude of the Azimuthal Error has been determined so as to make the sum of squares of residual discordances minimum.

ABSTRACTS of TABLES IV. and V.—TRANSITS of STARS and of the MOON, and Inferred R.A. of the MOON'S LIMB at TRANSIT.

Day, 1874.	Number of Transits of Clock Stars.	Number of Transits of Circumpolar Stars.	Mean Sidereal Time of Transits of Clock Stars.	Clock Slow on Local Sidereal Time.	Clock's Losing Rate.	Limb of Moon observed.	Clock Time of Transit of Moon's Limb over Meridian.	Right Ascension of Moon's Limb at Transit over Meridian.
			h m	s	s		h m s	h m s
September 1	7	1	2. 42	+46·68	+ 9·9	II.	3. 24. 8·40	3. 24. 55·29
13	5	{ Least Squares }	17. 19	+ 9·14	+ 1·55			
14	7	1	18. 58	+10·81	+ 2·21			
17	6	2	19. 25	+19·94	+ 3·30			
19	[illegible]	2	19. 8	+27·45	+ 3·68	I.	18. 15. 14·40	18. 15. 41·65
21	4	2	21. 50	+34·56	+ 3·00	I.	20. 16. 18·46	20. 16. 52·82
22	12	4	19. 45	+37·13	+ 2·92	I.	21. 16. 1·34	21. 16. 38·75
23	12	1	21. 34	+40·33	+ 3·44	I.	22. 14. 59·38*	....
			1. 42	+40·99	+ 3·53			
25	11	3	23. 5	+45·24	+ 2·99	I.	0. 5. 38·17	0. 6. 23·55
						II.	0. 7. 56·67	0. 8. 42·05
October 1	7	1	7. 9	+59·35	+ 2·05	II.	6. 10. 12·04	6. 11. 11·32
2	3	1	1. 36	+60·93	+ 2·11			
16	6	1	23. 16	+32·89	+ 2·30			
17	5	1	23. 43	+35·30	+ 2·27			
20	4	3	23. 18	+42·38	+ 2·20	I.	21. 46. 22·33	21. 47. 4·55
23	8	3	0. 39	+48·83	+ 1·80	I.	0. 31. 51·79†	0. 31. 40·55
24	11	2	0. 21	+50·54	+ 2·15	I.	1. 26. 55·86	1. 27. 46·40
25	7	1	1. 12	+53·20	+ 2·59	I.	2. 25. 38·57	2. 26. 31·81
						II.	2. 28. 3·35	2. 28. 56·61
26	7	2	1. 54	+55·58	+ 2·67	II.	3. 30. 16·16	3. 31. 12·31
27	10	2	3. 55	+58·84	+ 2·58	II.	4. 35. 41·48	4. 36. 40·38
28	1	0	5. 9	+61·38	+ 2·62	II.	5. 42. 44·74	5. 43. 46·19
29	7	3	4. 36	+64·16	+ 2·55	II.	6. 48. 51·51	6. 49. 55·93
November 16	7	3	4. 35	+30·63	+ 0·84	I.	21. 25. 14·20	21. 25. 44·42
23	8	3	5. 33	+26·42	− 0·78	I.	4. 0. 12·95	4. 0. 39·33
24	5	[illegible]	5. 20	+25·92	− 0·57	II.	5. 7. 51·28	5. 8. 17·08
25	6	{ Least Squares }	5. 3	+25·29	− 0·87	II.	6. 16. 38·15	6. 17. 3·46
28	3	1	7. 17	+22·52	− 0·10	II.	9. 22. 13·25	9. 22. 35·65
December 7	5	3	3. 42	+24·11	− 0·46			
8	11	4	4. 12	+23·54	− 0·59			
9	9	3	3. 41	+22·85	− 0·62			

* No further step is taken in the computation of the observation of September 23. I am not aware of the reason.—G. B. A.

† Apparently an error of 1^{m}.

TABLE VI.—LONGITUDE of POINT VENUS, RODRIGUEZ, from the MERIDIONAL TRANSITS of the MOON.

Day.		Observer.	Moon's Limb.	Observed R.A. of the Moon's Limb.	Longitude (East) by the Ephemeris, 4h. 13m. +	Correction to the Ephemeris.	Corrected Longitude, 4h. 13m. +	Weight.	Remarks.
1874.				h m s	s	s	s		
September	1	B	2 L	3. 24. 55·29	60·94 + 24·166 ε	− ·84	40·6	1	
	19	B	1 L	18. 15. 41·65	56·04 + 24·131 ε	− ·32	48·3	1	
	21	N	1 L	20. 16. 52·82	46·88 + 23·804 ε	− ·40	37·4	1	
	22	B	1 L	21. 16. 38·75	50·86 + 24·432 ε	− ·44	40·1	1	
	25	B	1 L	0. 6. 23·55	57·39 + 26·063 ε	− ·66	40·0	1	
	25	B	2 L	0. 8. 42·05	59·53 + 26·048 ε	− ·66	42·3	1	Defective Limb (0s·00).
October	1	B	2 L	6. 11. 11·32	63·26 + 22·452 ε	− ·92	42·6	1	
	20	H	1 L	21. 47. 4·55	46·71 + 25·661 ε	− ·42	35·9	1	Four Wires.
	23	H	1 L	0. 31. 40·55	52·54 + 26·096 ε	− ·58	37·4	½	One Wire only.
	24	B	1 L	1. 27. 46·40	60·90 + 24·354 ε	− ·67	44·6	1	
	25	H	1 L	2. 26. 31·81	58·67 + 23·798 ε	− ·76	40·6	1	Defective Limb (0s·48).
	25	H	2 L	2. 28. 56·61	69·14 + 23·798 ε	− ·76	51·0	1	
	26	N	2 L	3. 31. 12·31	62·97 + 22·482 ε	− ·82	44·5	1	
	27	B	2 L	4. 36. 40·38	61·43 + 21·603 ε	− ·87	42·6	1	
	28	N	2 L	5. 43. 46·19	66·35 + 21·459 ε	− ·90:	47·0	½	Four Wires. Clock correction unsatisfactory.
	29	H	2 L	6. 49. 55·93	60·58 + 22·223 ε	− ·86	41·5	1	
November	16	H	1 L	21. 25. 44·42	46·75 + 26·226 ε	− ·31	38·6	½	Clock correction uncertain. Stars with the Moon.
	23	H	1 L	3. 58. 7·30	60·00 + 21·796 ε	− ·69	45·0	1	Defective Limb (0s·01).
	23	H	2 L	4. 0. 39·33	60·16 + 21·772 ε	− ·69	45·1	1	
	24	N	2 L	5. 8. 17·08	56·86 + 20·960	− ·77	40·7	1	
	25	H	2 L	6. 17. 3·46	64·93 + 21·084 ε	− ·81	47·8	1	
	28	N	2 L	9. 22. 35·65	66·17 + 26·710 ε	− ·81	44·5	1	

TABLE VII.—ABSTRACT of LONGITUDE of POINT VENUS from the observed ZENITH DISTANCE of the MOON.

Observer, N. Moon's 1 L.

1874.	Number of Observations.	Correction to Longitude for Error of Sidereal Time. (s)	Mean inferred Longitude for each day, corrected, $4^h. 13^m.$ + (s)	Weight.
September 18	2	+ 1·29	36·29	65
October 17	[illegible]	1·27	46·31	131
19	4	1·30	30·38	87
22	2	1·36	37·13	91
24	4	1·30	36·22	103
November 14	4	1·28	50·37	87
15	8	1·32	53·22	124
16	6	1·36	51·25	92
18	4	1·42	34·20	58
19	4	1·42	35·70	126
22	2	+ 1·21	50·07	75

Mean with weights, $4^h. 13^m. 42^s·45$.

Observer, B. Moon's 1 L.

1874.	Number of Observations.	Correction to Longitude for Error of Sidereal Time. (s)	Mean inferred Longitude for each day, corrected, $4^h. 13^m.$ + (s)	Weight.
September 17	4	+ 1·38	50·28	85
18	2	1·29	45·58	66
21	2	1·24	47·83	75
October 16	6	1·28	51·92	112
18	3	1·27	54·17	68
20	7	1·34	57·18	95
23	8	+ 1·35	41·31	161

Mean with weights, $4^h. 13^m. 49^s·02$.

Observer, N. Moon's 2 L.

1874.	Number of Observations.	Correction to Longitude for Error of Sidereal Time. (s)	Mean inferred Longitude for each day, corrected, $4^h. 13^m.$ + (s)	Weight.
October 27	5	+ 1·14	33·47	115
29	6	1·15	42·35	87
November 24	8	1·10	27·73	112
25	2	+ 1·10	30·32	57

Mean with weights, $4^h. 13^m. 32^s·79$.

Observer, B. Moon's 2 L.

1874.	Number of Observations.	Correction to Longitude for Error of Sidereal Time. (s)	Mean inferred Longitude for each day, corrected, $4^h. 13^m.$ + (s)	Weight.
September 27	[illegible]	+ 1·29	40·79	160
October 26	[illegible]	1·00	36·89	65
26	4	+ 1·00	56·52	67

Mean with weights, $4^h. 13^m. 43^s·53$.

Table VII.—Abstract of Longitude of Point Venus from observed Zenith Distances of the Moon—*concluded.*

1874.	Number of Observations.	Correction to Longitude for Error of Sidereal Time.	Mean inferred Longitude for each day, corrected, $4^h. 13^m.$ +	Weight.
Observer, H. Moon's 1 L.				
		s	s	
September 19	3	+ 1·25	43·07	68
20	2	1·23	47·66	70
21	4	1·24	48·25	105
22	4	1·27	49·72	103
25	2	1·35	42·25	97
October 22	2	1·36	55·90	42
24	2	1·30	50·50	80
November 14	4	1·28	52·81	85
15	8	1·32	53·32	125
16	6	1·36	61·81	89
18	4	1·42	41·45	56
19	2	+ 1·42	43·30	89
Mean with weights, $4^h. 13^m. 49^s·27$.				

1874.	Number of Observations.	Correction to Longitude for Error of Sidereal Time.	Mean inferred Longitude for each day, corrected, $4^h. 13^m.$ +	Weight.
Observer, H. Moon's 2 L.				
		s	s	
September 26	12	+ 1·34	42·36	226
November 24	8	1·10	41·08	125
25	2	+ 1·10	35·67	42
Mean with weights, $4^h. 13^m. 41^s·24$.				

TRANSIT OF VENUS, 1874.

PART III.

EXPEDITION TO THE ISLAND OF RODRIGUEZ

(*continued*).

Section 2.

REPORT OF COMMANDER W. J. L. WHARTON, R.N., ON THE OBSERVATIONS AT POINT COTON.

With One Plate.

CONTENTS.

REPORT of COMMANDER W. J. L. WHARTON, R.N., on the POSITIONS of the SECONDARY OBSERVING STATIONS in RODRIGUEZ and on his own OBSERVATIONS of the TRANSIT of VENUS, December 8, 1874.*

1. POSITIONS of the SECONDARY OBSERVING STATIONS.

These positions were determined by triangulation from the primary station at Point Venus.

A base line of 2,503 feet, situated on the flat sand-covered coral reef, was measured, at low water, six times by means of two chains. The greatest difference was 2 feet.

This base was expanded by five well-proportioned and carefully observed triangles to 9882·3 feet, and from this last base three systems of triangles were started, all of which terminated at the Hermitage Islet, and one system terminating at Point Coton.

The theodolites employed had Azimuth circles of 8, 7, and 5 inches. No triangle was accepted the sum of whose angles differed more than 1′ from 180°. From the conformation of the island some ill-conditioned triangles were unavoidably admitted into the system, but the small angle was invariably at one of the known stations. To this circumstance, however, a part of the discrepancy in the result is due; but as the first system, although the best in point of number and in the forms of the triangles, entailed longer distances than could be accurately measured by the power of the small theodolites, the arithmetical mean of the three results for Hermitage Islet has been taken. From this point 12 true bearings were taken which differed 1½′ among themselves.

The following are the results:—

Distance of the station on Hermitage Islet (marked H on the Survey Plan) from the station (marked S) at Point Venus—

By the first system,	6 triangles,	26835·6	feet	*South*,	5213·4	feet *East*.
By the second system,	6 triangles,	26824·9	„	„	5230·5	„ „
By the third system,	12 triangles,	26845·1	„	„	5215·8	„ „
	Mean	26835·2	„	„	5220·0	„ „

* The details of Commander Wharton's surveying operations in the Island of Rodriguez are deposited in the Hydrographic Department at the Admiralty.

Applying corrections of a few feet at either end for the distances between the survey stations and the astronomical stations, and taking the geographical mile as 6,053 feet. Lieut. Hoggan's telescope was 4′. 25″·6 S. and $0^m. 3^s{\cdot}59$ East of the Altazimuth Pier at Point Venus.

Similarly my own station at Point Coton was 0′. 32″·3 S. and $0^m. 16^s{\cdot}98$ East of the Altazimuth Pier, Point Venus.

2. COMPARISONS of CHRONOMETERS with the CLOCKS at POINT VENUS.

The chronometers employed at Point Coton were —

Baker No. 1083............ Box, 2-day.
Poole No. 1086 .... Box, 2-day.
Molyneux No. 2280 .... Pocket-box, 2-day.

They were compared with the Transit and Altazimuth Clocks at Point Venus, before and after transportation to Point Coton, as follows :—

Approximate Local Mean Time, 1874.	Time by the Transit Clock.	Corresponding Chronometer Time.	Chronometer Compared.	Corresponding Chronometer Time.	Time by the Altazimuth Clock.
h	h m s	h m s		h m s	h m s
Dec. 7, 23	16. 20. 45·0	8. 11. 3·5	Baker	8. 13. 31·0	16. 23. 0·0
	16. 22. 10·0	2. 29. 38·0	Poole	2. 34. 56·0	16. 27. 17·0
	16. 25. 0·0	6. 51. 20·0	Molyneux	6. 57. 10·8	16. 30. 39·0
9, 0	17. 34. 50·0	9. 21. 3·0	Baker	9. 23. 7·5	17. 36. 38·0
	17. 36. 0·0	3. 39. 16·1	Poole	3. 42. 10·5	17. 38. 38·0
	17. 37. 20·0	7. 59. 25·0	Molyneux	8. 2. 32·2	17. 40. 11·0

3. TIMES of the bursting of ROCKETS sent up from MOUNT SIMON, simultaneously observed at POINT VENUS and at POINT COTON.

Approximate Local Mean Time, 1874.	At Point Venus			At Point Coton	
	Time by Transit Clock.			By Poole.	By Baker.
	Observer (Neate).	(Hoggan)	(Burton).	Observer (Wharton).	Observer (Langdon).
h	h m s	s	s	h m s	h m s
December 8, 8	1. 15. 38·4	38·0	37·9	5. 4. 29·6	11. 21. 36·7
	1. 19. 7·0	7·1	6·4	5. 7. 58·0	11. 25. 5·0
	1. 23. 22·9	22·4	22·6	5. 12. 12·4	——
	1. 36. 16·9	16·6	16·1	5. 25. 5·0	11. 42. 12·0

4. INTERCOMPARISONS of the CHRONOMETERS used at POINT COTON.

Approximate Mean Time.	Observer.	Time by Baker.	Time by Poole.	Time by Molyneux.
1874. h m		h m s	h m s	h m s
Dec. 8, 1. 13	W	10. 8. 51·3	4. 26. 0·0	——
		——	4. 28. 0·0	8. 46. 53·0
7. 57	,,	4. 53. 20·0	11. 10. 26·6	——
		——	11. 12. 5·0	3. 30. 57·2
8. 36	,,	5. 33. 10·0	11. 50. 16·7	——
		——	11. 53. 5·0	4. 11. 57·0
17. 46	,,	2. 43. 5·8	9. 0. 10·0	——
		——	9. 1. 0·0	1. 19. 50·6
18. 51	,,	3. 48. 26·0	10. 5. 30·0	——
		——	10. 6. 20·0	2. 25. 10·3
22. 0	,,	6. 56. 26·4	1. 13. 30·0	——
		——	1. 15. 30·0	5. 34. 19·6
22. 32	,,	7. 27. 56·5	1. 45. 0·0	——
		——	1. 46. 40·0	6. 5. 29·5
9, 1. 0	L	9. 57. 32·5	4. 14. 36·0	——

5. ERRORS and RATES of the CHRONOMETERS used at POINT COTON.

Name of Chronometer.	Approximate Local Mean Time.	How Compared with Transit Clock.	Chronometer Slow on *Point Venus* Mean Time.	Loss in 24^h.
	1874. h m		h m s	s
Baker........	Dec. 7, 23. 14	Direct Comparison.	+ 3. 2. 37·02	
	8, 8. 15	By Rockets.......	+ 3. 2. 36·10	− 3·11
	9, 0. 24	Direct Comparison.	+ 3. 2. 33·75	
Poole	7, 23. 15	Direct Comparison.	− 3. 14. 32·71	
	8, 8. 15	By Rockets.......	− 3. 14. 31·09	+ 3·02
	9, 0. 25	Direct Comparison.	− 3. 14. 29·54	
Molyneux	7, 23. 18	Direct Comparison.	+ 4. 26. 34·81	
	8, 8. 15	By Rockets.......	+ 4. 26. 37·08	+ 6·25
	9, 0. 26	Direct Comparison.	+ 4. 26. 41·32	

W. J. L. WHARTON.

The chronometer Poole was used for recording Captain Wharton's observations during the Transit of *Venus*. It will represent the mean of all three if its correction be taken as follows, remembering that Point Coton station was $16^s{\cdot}98$ East of Point Venus :—

h m s

At Internal Contact at *Ingress*, 3. 14. 12·79 *fast** on *Point Coton* Mean Time.

,, ,, *Egress*, 3. 14. 12·62 *fast* ,, ,,

G. L. T.

* In the Report presented to Parliament, 1877, July 16, the chronometer Poole was erroneously stated to have been *slow* on L. M. T.

OBSERVATIONS at POINT COTON, RODRIGUEZ, by Commander WILLIAM J. L. WHARTON, R.N., with a $2\frac{3}{4}$ Refractor by Troughton and Simms.

The observation spot was 20 feet from the edge of the sea cliff (30 feet) of Point Coton that faces the East, with the summit of the inshore cliff (where the triangulation beacon was) S. 73°. 03′ W. (true) 185 feet. The northern point of Point Coton is (by chart) 926 feet. By triangulation, the position was 0′. 32″·28 South and 4′. 14″·69 (diff. long.) East of the Altazimuth Hut at the main observatory on Point Venus.

The exact spot is marked by an iron stake fixed into the rock with lead.

On the 8th December three chronometers were conveyed to Point Coton by water, after being compared with the Transit clock of the Point Venus observatory; intercomparisons on arrival showed they had suffered no shocks.

Time was checked the same evening by rockets thrown up in the center of the island; two hours after the transit, the chronometers were again compared with the Transit clock, having been re-conveyed by water to Point Venus.

Time was taken by Nav. Lieut. Langdon, R.N., from the Solar chronometer *Poole* 1086.

The morning of the 9th was perfectly calm, and generally clear, but several clouds hung to the S.E., and threatened to cover the Sun at the moment of contact. About a minute after the critical phenomenon the Sun was hid from view for some minutes. The limb of the Sun was considerably agitated, probably by the rays passing through the thinner portions of the clouds above-mentioned; as the line of sight passed over no land, and the surf on the reef at 300 yards distance was quiet.

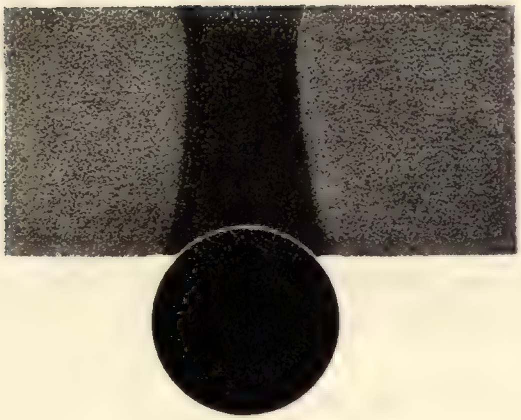
The planet was first seen at $9^h. 28^m$. At $9^h. 52^m$. I observed that the outer limb of Venus farthest from the Sun was illuminated; as I was not on the look out for this, it may have been visible earlier. At the same time I saw a distinct cone of shadow thrown away into space, but for no great distance, on the line joining centers of Sun and planet. (*See* Diagram I.)

The illumination of the outer limb of Venus broadened and increased in brilliancy up to simple internal contact, when for a moment it seemed as if there was to be no drop; Venus being apparently visible on the edge of the Sun, with light all round her. (*See* Diagram II.)

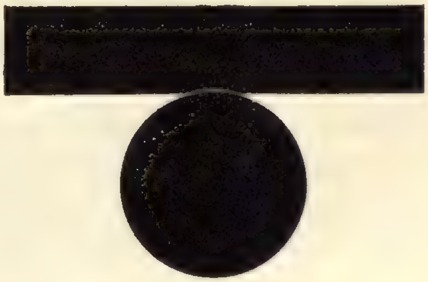
Immediately after this a blackish haze was discernible joining the planet and the continuation of the Sun's limb; but from the agitation of the limb,

Transit of Venus, 1874.

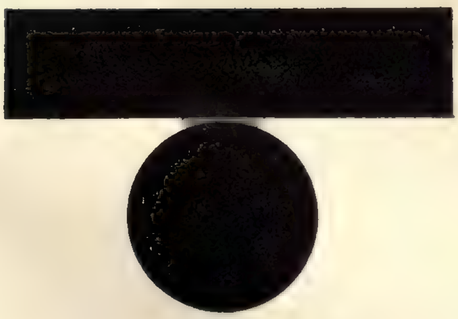
Observations at Point Coton, Rodriguez by Commander W.J.L. Wharton, R.N. with a telescope of $2\frac{3}{4}$ inches aperture, power 160.



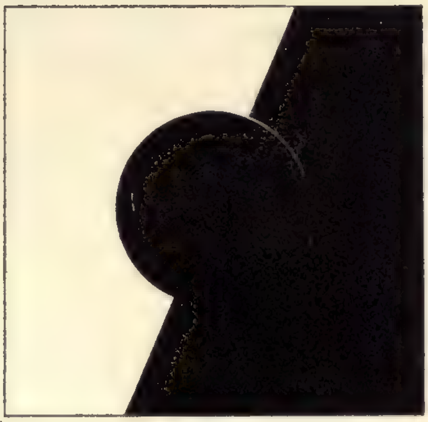
Ingress, Fig. 1.



Ingress, Fig. 2



Ingress, Fig. 3.



Egress, Fig. 4.

Dangerfield Lith. 22. Bedford St Covent Garden

this haze was not distinctly defined, and did not seem to change colour before disappearance. The moment of total disappearance of haze was tolerably defined, but I could not be certain to two or three seconds. The band of haze did not narrow at all before it broke, so far as I could see.

Venus on the Sun did not appear to me to be perfectly round. The eccentricity took the form of a protuberance in a direction about 20° farther from the vertex than the point of contact. Of this I would not be certain, but it so appeared to me.

At Egress the limb was much less disturbed than at Ingress. The brown haze appeared quickly, though not well defined at its edges, as a ligament; it was of considerable breadth, and after a few seconds darkened perceptibly; the exact instant of this was not very well marked.

When Venus' outer limb touched the Sun's limb, the appearance of light all round again was visible for a second.

The limb protruding into space was then again illuminated for nearly seven minutes; when the light gradually died out from the quarter nearest the vertex, leaving only the other quarter illuminated. This remained so for 14 minutes after Egress, or until nearly half the planet was clear of the Sun. (*See* Diagram 4.)

The power was 160, and the dark shade was a red glass of not a very deep tint.

I should say that Point Coton was undoubtedly the best position for the observation of the transit; but from the nature of the reef skirting it, it would have been impossible to get heavy instruments and stores landed without much risk and delay, not having any flat bottomed boats for the service; and there is no road nor path from Port Mathurin.

OBSERVATION of the TRANSIT.

At Ingress.

	Times by Chronometer Poole 1086. h m s
First saw Venus	9. 28.
Observed outer limb of Venus outside Sun illuminated	9. 52.
Observed cone of shadow	9. 53.
The outer limb of Venus being illuminated, there seemed to be no black drop for a few seconds; when that limb came in contact with the visible Sun light shone all round Venus. Time for this	9. 56. 26·4

	Time by Chronometer Poole 1086
	h m s
A moment after, a black haze was discernible, but from the great agitation of the Sun's limb (the morning being somewhat cloudy) it was not distinctly defined, and did not visibly change colour. The moment of total disappearance of black hazy drop as nearly as could be guessed was	9. 57. 3·0

At Egress.

Agitation of Sun's Limb not so great.

First appearance of brown haze	1. 25. 39·6
First appearance of black hazy drop, not very distinctly marked	1. 25. 48·1
Appearance of light all round the planet at circular contact ...	1. 26. 26·9
The illumination of the outer limb disappeared from the whole arc of the planet outside the Sun, and was confined to the quarter farthest away from the vertex at about	1. 30. 0·0
Disappearance of illumination from the quarter of Venus farthest from vertex	1. 40. 40

With the corrections of the chronometer *Poole* 1086 given on page 383, assuming the Latitude 19°. 40′. 54″, Longitude $4^{h}. 13^{m}. 59^{s}\cdot5$ East of Greenwich, we have the following results of Commander Wharton's observations:—

Phenomenon observed.	Recorded Time by Solar Chronometer Poole 1086.	Local Sidereal Time.	Greenwich Sidereal Time.	Local Tabular Distance of Centers of Sun and Venus.
Internal Contact at Ingress.				
	h m s	h m s	h m s	′ ″
"*Simple internal contact*" - -	9. 56. 26·4	11. 52. 54·3	7. 38. 54·8	15. 39·01
"*Total disappearance of black hazy drop.*"	9. 57. 3·0	11. 53. 31·0	7. 39. 31·5	15. 37·86

Phenomenon observed.	Recorded Time by Solar Chronometer Poole 1086.	Local Sidereal Time.	Greenwich Sidereal Time.	Local Tabular Distance of Centers of Sun and Venus.
Internal Contact at Egress.				
	h m s	h m s	h m s	′ ″
"*First appearance of brown haze*" -	1. 25. 39·6	15. 22. 41·7	11. 8. 42·2	15. 41·36
"*First appearance of black hazy drop.*"	1. 25. 48·1	15. 22. 50·3	11. 8. 50·8	15. 41·64
"*Circular contact*" - - -	1. 26. 26·9	15. 23. 29·2	11. 9. 29·7	15. 42·91

For Internal Contact at *Ingress*, "Total disappearance of black hazy drop," taking $R = 976''\cdot80$, $r = 31''\cdot42$, and mean solar parallax $= 8''\cdot950\left(1 + \frac{n'}{100}\right)$, we have the equation—

$$+7''\cdot52 = +0''\cdot1935\,n - \cdot6102\,\delta\,\text{R.A.} - \cdot7500\,\delta\,\text{N.P.D.} - 0''\cdot0313\,\delta t - \delta R + \delta r.$$

For Internal Contact at *Egress*, "First appearance of brown haze," taking $R = 976''\cdot82$, r and n as before—

$$+4''\cdot04 = -0''\cdot0274\,n - \cdot2178\,\delta\,\text{R.A.} - \cdot9717\,\delta\,\text{N.P.D.} + 0''\cdot0332\,\delta t - \delta R + \delta r.$$

G. L. T.

TRANSIT OF VENUS, 1874.

PART III.

EXPEDITION TO THE ISLAND OF RODRIGUEZ

(*continued*).

Section 3.

REPORT OF LIEUTENANT ROBERT HOGGAN ON THE OBSERVATIONS AT HERMITAGE ISLAND.

With One Plate.

CONTENTS.

Lieut. R. HOGGAN'S OPERATIONS at HERMITAGE ISLAND, RODRIGUEZ.

THE small islet on the south side of the Island of Rodriguez, named on the Admiralty charts Hermitage Island, having been selected for the position of a secondary telescope for observation of the actual Transit of *Venus*, Lieut. Hoggan, accompanied by Lieut. W. N. Moore, R.N., of H.M.S. *Shearwater*, proceeded there on the 30th November 1874, taking with him a 4-inch refracting telescope by Dollond, with tripod stand, two sextants, a mercurial artificial horizon with cover, and the two box chronometers—

$$\left.\begin{array}{l}\text{Hewitt 732}\\ \text{Cotterell } \frac{919}{2535}\end{array}\right\}\text{beating half-seconds;}$$

also the "pocket" chronometer Parkinson and Frodsham No. 4530, beating five times in two seconds.

Lieuts. Hoggan and Moore remained encamped on the islet until December 10. The errors of the chronometers on local time were determined by a continuous series of observations of equal altitudes of the Sun from December 3 to December 9. At 8 p.m. on December 2, 6, 8, and 9, five rockets were sent up from the summit of Mount Simon (by a party from H.M.S. *Shearwater*). These rockets were visible from Lieut. Hoggan's and Captain Wharton's stations as well as from the head station at Point Venus. The instants of the bursting of the rockets were noted independently by Lieut. Neate and Mr. Burton at Point Venus, and by Lieuts. Hoggan and Moore at Hermitage. For various reasons the observations of December 2 and 6 were rejected. In the meantime, Captain Wharton connected the station on the islet by a system of triangles with the general survey of the island, as fully described in his Report (page 381).

From this triangulation the station on Hermitage Islet was $4'.\ 25''\cdot6$ South and $0^{m}.\ 3^{s}\cdot59$ East of the Altazimuth pier at Point Venus. The Latitude of Hermitage Station is therefore $19^{\circ}.\ 44'.\ 47''\cdot7$, and the Longitude $4^{h}.\ 13^{m}.\ 46^{s}\cdot1$ East of Greenwich.

By comparing the errors of the three chronometers on local mean solar time, as determined from the equal altitudes observed on December 7 and 9, with their errors on Point Venus mean time, as determined from the well-observed rocket signals on the evening of December 8, the difference of longitude between the two stations appears to be $3^{s}\cdot87$, a proof of the

accuracy of the observations for local time made on the islet. The adopted Longitude of the Hermitage Station is 4^{h}. 13^{m}. 46^{s}·1 E.

The details of observations on December 7, 8, and 9 only have been selected for publication.

EQUAL DOUBLE-ALTITUDES of the SUN observed with a SEXTANT at HERMITAGE ISLAND, RODRIGUEZ, and INFERRED ERROR of the POCKET CHRONOMETER PARKINSON and FRODSHAM No. 4530.

[The approximate Index Correction to Sextant Reading was found to be −2′. 50″, and the Collimation adjustment was satisfactory.]

Civil Day, 1874. (Observer.)	Recorded Time by Parkinson and Frodsham, Sun *East.*	Reading of Sextant and Limb of Sun.	Recorded Time by Parkinson and Frodsham, Sun *West.*	Parkinson and Frodsham Slow on Local Mean Time at Apparent Noon.
	h m s	° ′	h m s	m s
December 7 (M)	8. 49. 57·0	99. 0 U	2. 40. 30·0	+ 6. 22·96
	8. 52. 18·0	99. 0 L	2. 38. 9·0	
	8. 54. 17·4	101. 0 U	2. 36. 9·6	+ 6. 23·01
	8. 56. 39·2	101. 0 L	2. 33. 47·6	
	8. 58. 37·6	103. 0 U	2. 31. 48·5	+ 6. 23·20
	9. 0. 59·8	103. 0 L	2. 29. 27·0	
	9. 7. 19·5	107. 0 U	2. 23. 6·3	+ 6. 23·21
	9. 9. 41·2	107. 0 L	2. 20. 45·6	
	9. 11. 40·0	109. 0 U	2. 18. 46·4	+ 6. 23·10
	9. 14. 1·6	109. 0 L	2. 16. 25·0	
	9. 16. 0·6	111. 0 U	2. 14. 26·0	+ 6. 22·82
	9. 18. 22·8	111. 0 L	2. 12. 4·6	
	9. 20. 21·5	113. 0 U	2. 10. 6·2	+ 6. 22·53
	9. 22. 42·8	113. 0 L	2. 7. 44·6	
(H)	9. 31. 12·0	118. 0 U	1. 59. 16·4	+ 6. 22·49
	9. 31. 33·0	118. 10 U	1. 58. 54·0	
	9. 31. 55·0	118. 20 U	1. 58. 32·0	+ 6. 23·19
	9. 32. 15·6	118. 30 U	1. 58. 9·6	
	9. 32. 37·2	118. 40 U	1. 57. 49·6	+ 6. 23·09
	9. 32. 58·8	118. 50 U	1. 57. 27·6	
	9. 33. 20·4	119. 0 U	1. 57. 6·0	+ 6. 23·44
	9. 34. 3·2	119. 20 U	1. 56. 21·6	
	9. 34. 47·2	119. 40 U	1. 55. 38·8	+ 6. 23·39
	9. 35. 9·0	119. 50 U	1. 55. 16·4	
	9. 35. 30·4	120. 0 U	1. 54. 54·4	+ 6. 23·07
	9. 37. 52·7	120. 0 L	1. 52. 35·2	
December 9 (M)	8. 37. 41·6	93. 0 U	2. 54. 33·0	+ 6. 22·09
	8. 40. 4·8	93. 0 L	2. 52. 10·8	
	8. 42. 3·2	95. 0 U	2. 50. 10·5	+ 6. 22·92
	8. 44. 24·8	95. 0 L	2. 47. 48·2	
	8. 46. 25·2	97. 0 U	2. 45. 49·2	+ 6. 22·49
	8. 48. 46·8	97. 0 L	2. 43. 27·2	

TIMES, simultaneously recorded at POINT VENUS and at HERMITAGE ISLET, of the bursting of ROCKETS sent up on MOUNT SIMON.

Approximate Mean Time.	At Point Venus. Transit Clock Times. Observer (N.)	(B.)	(W.)	(L.)	At Hermitage Islet. Times by Chronometer Hewitt. Observer (H).	Times by Chronometer Parkinson and Frodsham. Observer (M).
1874. h	h m s	s	s	s	h m s	h m s
December 8, 8	1. 8. 32·0	32·0			7. 54. 6·0	7. 53. 41·2
	1. 15. 38·4	37·9			8. 1. 10·5	8. 0. 46·0
	1. 19. 7·0	6·4			8. 4. 39·3	8. 4. 14·2
	1. 23. 22·9	22·6			8. 4. 54·0	8. 8. 29·3
	1. 36. 16·9	16·1			8. 21. 45·9	8. 21. 21·2
9, 8	1. 14. 32·9	32·3	32·4	33·0	7. 56. 7·8	7. 55. 44·5
	1. 19. 55·8	55·1	55·2	55·7	8. 1. 29·6	8. 1. 6·4
	1. 24. 36·1	36·1	36·0	36·0	8. 6. 9·9	8. 5. 46·4
	1. 29. 42·1	42·1	42·1	42·1	8. 11. 14·4	8. 10. 51·6
	1. 34. 42·0	41·9	41·6	4·19	8. 16. 13·3	8. 15. 50·1

INTERCOMPARISONS of CHRONOMETERS at the HERMITAGE ISLET.

Approximate Civil Time, 1874.	Observer.	Time by Hewitt.	Corresponding Time by Parkinson and Frodsham.	Time by Hewitt.	Corresponding Time by Cotterill.
h		h m s	h m s	h m s	h m s
Dec. 7, 9 a.m.	H	8. 42. 38·0	8. 42. 13·0	8. 46. 55·0	8. 45. 45·5
noon		0. 8. 23·0	0. 7. 58·0	0. 6. 56·0	0. 5. 45·7
3 p.m.		[H − P&F. 25·0]			
10 p.m.		10. 4. 30·0	10. 4. 4·8		——
8, 8 a.m.	H	8. 19. 41·0	8. 19. 15·8	8. 22. 19·0	8. 21. 4·5
noon		0. 10. 49·0	0. 10 23·8	0. 15. 10·0	0. 13. 54·6
7 p.m.		7. 22. 40·0	7. 22. 15·2	7. 27. 9·0	7. 25. 52·3
9, 5 a.m.	H	5. 0. 29·0	5. 0. 6·0	5. 5. 7·0	5. 3. 48·4
7 a.m.		7. 16. 34·0	7. 16. 11·2	7. 31. 19·0	7. 29. 59·9
8 a.m.		8. 28. 59·0	8. 28. 26·3		
10 a.m.		9. 45. 1·0	9. 44. 38·2	9. 25. 0·0	9. 23. 40·5
11 a.m.		10. 43. 53·0	10. 43. 30·3	10. 48. 15·0	10. 46. 55·3
noon		11. 58. 7·0	11. 57. 44·3	0. 0. 20·0	11. 59. 0·0
3 p.m.		2. 59. 25·0	2. 59. 2·0		
7 p.m.		7. 14. 32·0	7. 14. 9·0	7. 22. 1·0	7. 20. 39·9
8 p.m.		8. 27. 34·0	8. 27. 11·0		

ADOPTED ERRORS and RATES of the CHRONOMETERS at HERMITAGE ISLET.

BY THE OBSERVED EQUAL ALTITUDES.			BY THE ROCKET SIGNALS.			
1874.	Chronometer Slow on *Local* Mean Time.	Loss in 24^h.	1874.		Chronometer Slow on *Point Venus* Mean Time.	Loss in 24^h.
Hewitt No. 732.						
	m s	s		h m	m s	s
Dec. 7, apparent noon	+ 5. 58·04					
8,		+ 0·86	Dec. 8,	8. 12	+ 5. 54·91	+ 1·24
9, apparent noon	+ 5. 59·77		9,	8. 12	+ 5. 56·15	
Cotterell No. $\frac{919}{2535}$.						
Dec. 7, apparent noon	+ 7. 8·34					
8,		+ 5·71	Dec. 8,	7. 33	+ 7. 11·58	+ 5·65
9, apparent noon	+ 7. 19·77		9,	7. 38	+ 7. 17·20	
Parkinson and Frodsham No. 4530.						
Dec. 7, apparent noon	+ 6. 23·04					
8,		− 0·28	Dec. 8,	8. 12	+ 6. 19·67	− 0·32
9, apparent noon	+ 6. 22·47		9,	8. 12	+ 6. 19·35	

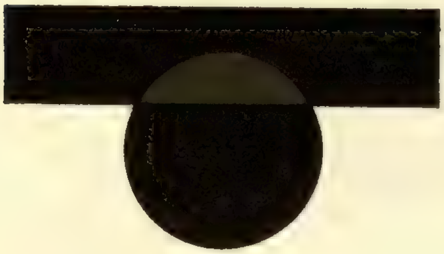
For the *Ingress* of Venus the pocket chronometer Parkinson and Frodsham No. 4530 may be considered $6^m. 21^s·96$ *slow* on Local Mean Time; for the *Egress*, $6^m. 22^s·35$ *slow* on Local Mean Time. This chronometer will then represent the mean of the three as well as the mean of both methods of determining the local time.

Observation of Ingress.

On the morning of the transit, before sunrise, the sky was cloudless, and the atmosphere so very clear that stars could be observed rising from the

Transit of Venus 1874 December 8.

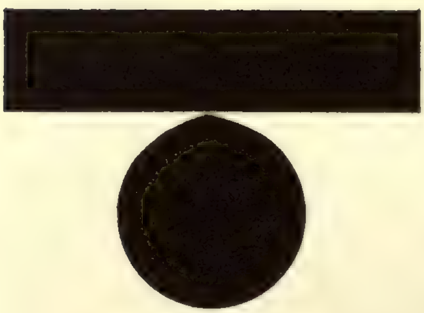
Observations at Hermitage Islet, Rodriguez by Lieutenant R. Hoggan, R.N. with a telescope of 4 inches aperture, power 120 for Ingress, 160 for Egress.



Ingress Fig. 1.

Ingress Fig. 2.

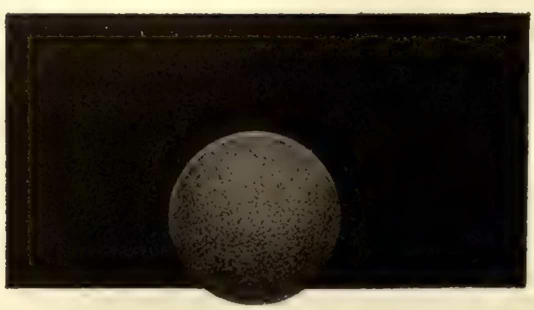
Ingress Fig. 3.



Egress Fig. 1.

Egress Fig. 2.

Egress Fig. 3.



Egress Fig. 4.

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sea horizon; but when daylight broke some very thick black clouds appeared near that point of the horizon where the Sun was rising.

The Sun rose through a break in the clouds, and remained visible until he had attained an altitude of about 10°, when a very light breeze sprang up and swept the clouds slowly across his face, totally obscuring it. The time of external contact at Ingress had passed about eight minutes before the Sun reappeared, and when first I observed Venus she appeared with one-fourth of her disc on the Sun.

There seemed to be a very great amount of atmospheric disturbance, making the limbs of the Sun and Venus appear in a state of very rapid vibration. At this time I was using the lowest power in the telescope (about 70).

In about a minute's time the Sun became obscured, and did not reappear for an interval of eleven minutes.

At $6^h. 21^m. 40^s.$ the cloud cleared away, and I again saw the planet with about half the disc on the Sun; and, as there seemed some prospect of the Sun remaining unobscured for some short time, I shifted the eye-piece to one with a power of 120, and used a yellow dark glass.

The atmospheric disturbance round the limbs of the Sun and planet was now rendered more apparent, and Venus appeared very much distorted.

At $6^h. 24^m. 35^s{\cdot}2$ I noticed for the first time that part of the disc of Venus outside the Sun's limb. It appeared of a reddish brown colour, whilst that part of her disc which had entered on the Sun's disc was intensely black (Fig I.).

About two minutes after, small semi-opaque clouds obscured the Sun from time to time; and at $6^h. 28^m. 44^s$, just about three minutes previous to the time of internal contact by the N.A., the Sun became totally obscured.

Before the reappearance of the Sun, Lieut. Moore, who was noting the times, informed me that the time of contact had passed.

At $6^h. 33^m. 0^s.$ the Sun's disk could be just seen through some thin clouds, obliging me to observe without a dark glass, and I fancied I saw the planet still in connection with the limb of the Sun. Fortunately, just at this moment ($6^h. 33^m. 17^s{\cdot}5$) a break in the clouds revealed the Sun in all its brightness. I had to withdraw my eye instantly, and put on a red dark glass, which, as it happened, was of too light a shade; but there was no time to exchange it then, and I was very much surprised to see that Venus had not yet arrived at her position of internal circular contact, the chord of cusps being a little less than one-fourth of the diameter of the planet.

At $6^h. 34^m. 4^s{\cdot}8$ I observed internal circular contact with as much precision as the limbs of the Sun and Venus would admit of in such a state of vibration.

Although I watched carefully, I noticed no alteration in the phenomena of circular contact until $6^h. 34^m. 16^s$, when the planet's disk suddenly appeared to be connected with the Sun's limb by a band of the same degree of blackness as the planet, and about one-fourth of its diameter in width (Fig. 2). I can speak with certainty of the decided and instantaneous appearance of the phenomenon.

At $6^h. 34^m. 57^s$, the planet having advanced farther on the Sun's disc, the ligament had increased in length to a small extent, rendering the phenomenon of the connecting ligament still more striking than heretofore. At this most critical time an interval of one minute and ten seconds seems to have ensued, during which no change of phenomena took place. I pointed this out to Lieut. Moore immediately after the observation of Ingress, and asked him if he thought it possible that a mistake in the minute might have been made in recording the times, but he was certain in his own mind that they were recorded correctly; and although the interval did not seem to me of such a long duration, my attention being so absorbed in the phenomena then occurring, my idea of the duration cannot have been otherwise than imperfect. Therefore I can offer no explanation for this extraordinarily long interval, during which occurred this absence of change of phenomena.

At $6^h. 36^m. 7^s{\cdot}9$, in consequence of a slight diminution in the atmospheric disturbance and in the breadth of the ligament, the ligament assumed a more definite shape.

At $6^h. 36^m. 17^s{\cdot}4$ the ligament appeared to be decreasing in width very perceptibly, and at $6^h. 36^m. 32^s{\cdot}8$ it had faded away, and light appeared all round the planet's disc (Fig. 3). Nevertheless, the planet was very near to the Sun's limb, and on watching very attentively I fancied at $6^h. 36^m. 43^s{\cdot}2$ I saw the light interrupted by an extremely fine ligament which broke; and immediately after, light was again visible all round the disc of the planet. This last phenomenon may possibly have been due to one of the waves of vibration round Venus's limb interrupting the light, as the appearance and disappearance were almost instantaneous.

At $6^h. 41^m.$ the Sun became again obscured, and did not appear again for an interval of a quarter of an hour.

On its reappearance most of the atmospheric disturbance had ceased, and shortly after I was enabled to use the highest power in the telescope.

The planet when on the Sun's disc appeared of a perfectly circular form, and there was no appearance of refracted light round its edge, which was very sharp, the whole body of the planet being intensely black.

In the original record of the observation of *Ingress* all the phenomena attached to the times were registered instantly by Lieut. Moore, with the exception of the important phenomenon of circular contact at $6^h. 34^m. 4^s{\cdot}8$, and the less important phenomena attached to the times $6^h. 33^m. 36^s{\cdot}2$ (regarding which time there is a correction on the left-hand side of the page to $6^h. 33^m. 56^s{\cdot}2$, to which Lieut. Moore's initials are appended), $6^h. 36^m. 7^s{\cdot}9$, and $6^h. 36^m. 17^s{\cdot}4$, which were written by myself, from memory, immediately after.

The pocket chronometer Parkinson and Frodsham was used for recording the times of the observation of Ingress. It was compared, both before and after Ingress, with the other two chronometers, Hewitt and Cotterell.

Lieut. Moore devoted the interval between Ingress and Egress to observations of the altitude of the Sun, for the determination of local time.

Note by the Astronomer Royal.

The remark made by Lieut. Hoggan, on the trifling character of the change of phenomena between $6^h. 34^m. 57^s$. and $6^h. 36^m. 7^s{\cdot}9$, throws a doubt on the accuracy of the observation.

It seems possible that at $6^h. 33^m. 17^s{\cdot}5$, $6^h. 34^m. 4^s{\cdot}8$, $6^h. 34^m. 16^s$, $6^h. 34^m. 57^s$, $10^h. 3^m. 18^s{\cdot}2$, $10^h. 3^m. 51^s$, $10^h. 3^m. 56^s$, and $10^h. 4^m. 47^s$, the minute may have been registered 1^m. too small; while at $6^h. 36^m. 7^s{\cdot}9$, $6^h. 36^m. 17^s{\cdot}4$, $6^h. 36^m. 32^s{\cdot}8$, and $6^h. 36^m. 43^s{\cdot}2$, it was registered correctly.

These changes of several numbers appear to reconcile the observations at Hermitage Island with other observations in Rodriguez.

Errors may sometimes be caused by noncoincidence of the minute-hand with the minute-line when the second-hand points to 60. It was, however, an Official Instruction to the Assistant who should read the clock or chronometer, "It is desirable that he assure himself of the correspondence of indications of the minute-hand and the second-hand."

Observation of Egress.

About twenty minutes before internal contact at Egress, the chronometers being intercompared, I commenced observing the planet.

The observation of Egress was made under the most favourable circumstances. The Sun's limb and the planet's limb were both very sharply

defined with the highest power (160) in the telescope. The dark glass used was yellow. The first indication of approaching contact which I observed, at $10^h. 3^m. 18^s{\cdot}2$, was an elongation of the planet's limb in the direction of that of the Sun. This did not appear to remain steady, but moved backwards and forwards towards the Sun's limb without, however, entirely interrupting the light (Fig. 1).

Up to the time indicated by $10^h. 3^m. 51^s.$ the light was not entirely interrupted, but at $10^h. 3^m. 56^s.$ light was no longer visible between the limbs of the Sun and Venus, being interrupted by a band of about one-eighth of the diameter, and the same degree of blackness as the planet (Fig. 2). The width of the band increased to about one-fourth of the planet's diameter up to the time of circular contact, which phenomenon was observed at $10^h. 4^m. 47^s.$ (Fig. 3).

Having noticed the appearance of that portion of the planet's disc outside the Sun's limb at Ingress, I now directed my particular attention to it again; and at $10^h. 7^m.$ I first perceived it emerging from the Sun's limb.

It appeared, as at Ingress, of a reddish brown colour.

Shortly afterwards I noticed that its outer limb became faintly illuminated with a yellow light, presenting something of the appearance of a very young moon with her horns directed towards the Sun's limb (Fig. 4).

The portion of the planet outside the Sun's limb retained the same appearance in regard to colour and illumination of the outer limb up to within a few moments of external contact, when the slow motion of the telescope in zenith distance failed to act; and before I could remedy this, and bring the Sun into the field of the telescope once more, the planet had disappeared from off the Sun's disc, and, although I searched for her outside that portion of the Sun's limb off which she had passed, I could discern nothing.

After the observation of Egress the chronometers were intercompared.

For Lieut. Hoggan's observations we have, therefore, the following results, assuming the Latitude 19°. 44′. 47″ S., Longitude $4^h. 13^m. 46^s$. East of Greenwich:—

Phenomenon observed.	Time recorded by Parkinson and Frodsham 4530.	Local Sidereal Time.	Greenwich Sidereal Time.	Local Tabular Distance of Centers of Sun and Venus.
Internal Contact at Ingress.				
	h m s	h m s	h m s	′ ″
"Circular contact" - - -	6. 33. 17·5	11. 50. 19·3	7. 36. 33·2	15. 43·56
or	6. 34. 17·5	11. 51. 19·5	7. 37. 33·4	15. 41·64
"Ligament decreasing in width" -	6. 36. 17·4	11. 53. 19·7	7. 39. 33·6	15. 37·82
"It had faded away" - -	6. 36. 32·8	11. 53. 35·2	7. 39. 49·2	15. 37·34
Internal Contact at Egress, the recorded times being increased one minute.				
"Light not entirely interrupted" -	10. 4. 51·0	15. 22. 28·0	11. 8. 41·9	15. 41·38
Light no longer visible between the limbs.	10. 4. 56·0	15. 22. 33·0	11. 8. 46·9	15. 41·54

The mean of the times recorded for "Ligament decreasing in width" and "It had faded away" at *Ingress* gives the following equation for distance of centers, taking $R = 976''·80$, $r = 31''·42$, and the mean solar parallax $= 8''·950 \left(1 + \frac{n}{100}\right)$:—

$$+7''·80 = +0''·1936\, n + ·6096\, \delta\, \text{R.A.} - ·7504\, \delta\, \text{N.P.D.} - 0''·0303\, \delta\, t - \delta\, R + \delta\, r.$$

Similarly, the mean of the two times for Internal Contact at *Egress*, taking $R = 976''·82$, r and n as before, gives—

$$+3''·94 = -0''·0271\, n - ·2179\, \delta\, \text{R.A.} - ·9717\, \delta\, \text{N.P.D.} + 0''·0332\, \delta\, t - \delta\, R + \delta\, r.$$

G. L. T.

TRANSIT OF VENUS, 1874.

PART IV.

EXPEDITION TO KERGUELEN ISLAND,

UNDER

THE REVEREND S. J. PERRY, F.R.S.

SECTION I.

OBSERVATIONS AT OBSERVATORY BAY.

With One Plate.

SECTION II.

OBSERVATIONS AT SUPPLY BAY.

With One Plate.

SECTION III.

CHRONOMETRICAL CONNEXION OF STATIONS IN ROYAL SOUND.

SECTION IV.

OBSERVATIONS AT THUMB PEAK.

TRANSIT OF VENUS, 1874.

PART IV.

EXPEDITION TO KERGUELEN ISLAND.

Section 1.

OBSERVATIONS AT OBSERVATORY BAY.

With One Plate.

INDEX.

Transit of Venus 1874, Kerguelen Island.

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Voyage, and Names of Observers.

The Expedition for observation of the Transit of Venus at Kerguelen's Land sailed from England in the *Windsor Castle*, a steamship of the "Donald Currie Line," on 1874, June 20, and arrived at Cape Town on July 20. Ample arrangements had been made by the Admiralty for carrying the party with little delay to Kerguelen's Land; but, from accidents to their own and other ships, which rendered necessary a change of the vessels intended for Kerguelen, the observers were delayed in Cape Town longer than had been anticipated. Finally, however, H.M.S. *Volage*, Captain Fairfax, R.N., (with the observers and some instruments) and H.M. storeship *Supply*, Staff-Commander Inglis, R.N., (carrying instruments, &c.) sailed on September 18 and 17, and were in company from September 19 till they approached Kerguelen, when they were separated by very heavy weather. Finally, the *Volage* anchored in Island Harbour, Royal Sound, on October 8; and the *Supply* joined her on October 11.

The Astronomical party consisted of the following gentlemen:—

Rev. S. J. Perry, F.R.S., *Superintendent.*
Lieutenant Coke, R.N.
Lieutenant Corbet, R.N.
Lieutenant Goodridge, R.N.
Rev. W. Sidgreaves.
W. Bagnall Smith.

The Site at Observatory Bay, Kerguelen Island.

But little was known of Royal Sound, in the S.E. of Kerguelen Island, until it was visited and explored by Captain (now Sir George) Nares, in H.M.S. *Challenger*, in 1874. His Report and his partial survey of this region reached England before the departure of the Transit of Venus Expedition, and decided the matter as to the best place for the head-quarters of the Expedition. In spite of very bad weather, Mr. Perry and Captain Fairfax, accompanied by Commander Bayley, of the American sealing schooner *Emma Jane*, visited many parts of the shores of the Sound, and ultimately selected

a site on the southern side of the entrance of an inlet or bay, in the N.W. corner of the Sound, in lat. 49°. 25′·2 S., long. 69°. 53′·5 E. This inlet was named OBSERVATORY BAY, and is shown in the plan of Royal Sound (Plate XVI.), as surveyed by Lieutenant VIVIAN, R.N., of H.M.S. *Volage.*

The wooden observatories and dwelling-house were erected on nearly level ground, about 50 feet above the sea. Constant snow-storms and rains interrupted the work of landing and erecting the huts and instruments; the land had to be drained, roads made, and a pier constructed; but, with the efficient assistance rendered by Captain Fairfax and the officers and men of H.M.S. *Volage*, most of the work on shore was finished by October 26, when the first observations were taken.

The Transit clock, by E. Dent and Co., of London, numbered 1915, was similar to that used at Honolulu. Its tripod rested upon stakes driven deeply into the ground through holes cut in the flooring of the observatory.

MERIDIONAL OBSERVATIONS.

The Transit instrument, its piers, the hanging level, and the wooden observatory, were, in every respect, similar to those used at the other head stations, and have been fully described in Part I., at page 9 *et seq.*

For the foundations of the transit pier, the subsoil was excavated until the rock was reached. A bed of concrete was laid on the rock and levelled. When this had set, a brick pier was built up to the level of the ground to receive the great stone. The building of the piers was much impeded by the rains; and, although all possible care was taken with the foundations, subsequent observations proved that the instrument was unstable at all times, but especially after heavy rains. The instrument was fairly in the meridian by November 3.

The value of one revolution of the eye-piece micrometer-screw (which carried all five wires of the reticule) was found at different times, from numerous observations of close circumpolar stars, the mean value being 56″·09. The integer revolutions were numbered in the observing books so as to increase when the wire was carried towards the screw head; the center wire coincided approximately with the optic axis when the reading was 20^{r}·5. The position of the transit-axis is always denoted by the record of the micrometer-screw head being on the east or west side of the telescope.

The system of wires remained perfect during the series of observations, and the *equatorial intervals from the central wire*, determined from 400 transits, are:—

		$''$
Wire	I.	+ 427·4
	II.	+ 214·4
	III.	0·0
	IV.	− 214·6
	V.	− 426·8

The order of the wires refers to the order in which stars above the pole transit them with the micrometer west.

The center wire has always been considered to represent the mean of wires.

The *Zero of Collimation*, or the reading of the micrometer when the center wire coincided with the optic axis, was determined nearly every day by observations of a distant mark with reversed positions of the transit axis. The distant mark was some sharply-defined feature of the rock (different in different observations) seen projected against the northern sky.

A Collimator, consisting of a telescope temporarily mounted on a tripod stand, was also frequently used. All these observations, given in Table I., indicate that some of the screws at the eye end of the instrument were loose, probably the ring clamp-screw.* The cause, however, was not discovered during the course of observations; and consequently, throughout the entire series, the Zero of Collimation is subject to an uncertainty, corresponding to about 3″ of arc; and it is probable that the relation between the center wire and the optic axis was liable to be disturbed every time that the micrometer-screw was touched. The adopted zero for each night is enclosed in a bracket, thus [20·550].

The *Level Error* was found with the hanging spirit-level; the value of the graduations engraved on the glass bubble was tested by the makers before the Expedition left England, when it was found that 41 divisions were equivalent to one minute of arc, which value has been used throughout. (Table II.)

Determinations of the *inequality of the pivots* were made in 1873, November, 1874, November, and 1875, January. On all three occasions it was found

* The ring-clamps of the Honolulu and New Zealand instruments worked loose during the outward voyages, and caused similar trouble at first.

that the correction to the level-error with the micrometer west was $-0''.80$, and this value has been applied throughout.

The *Error of Azimuth* (Table III.) has been found in the usual way by combining the observed transits of two stars of suitable declinations corrected for level and collimation. Occasionally, the observations of the north mark have been used to determine the azimuth-error; but such was the instability of the instrumental mounting, that it is never safe to deduce the clock-error, unless a circumpolar star was observed at the same time as the clock stars. For this reason several transits of the Moon cannot be utilised. No stars were observed near the zenith; the rate of the clock, however, appears to have been exceptionally steady.

The transits (abstracted in Table IV.) have been reduced in the manner described in the Introduction to the Honolulu Observations. Imperfect transits have been reduced to the center wire by means of the equatorial intervals given above.

The stars observed for clock-error were taken from the Nautical Almanac for 1874 or 1875. The Mean Right Ascensions are taken from the Greenwich Catalogue of 2760 Stars for the Epoch 1864, the reductions from mean to apparent place being taken from the Nautical Almanac.

For the determination of azimuth-error, Mr. Stone's Catalogues of 8 and 78 Southern Circumpolar Stars were used. The mean places for 1874, January 1, have been given in Part III., page 356.

The true clock time of transit of the Moon's limb in the *eighth* column requires a further correction of $-0^{s}.02$ for diurnal aberration.

The transits of stars selected for publication are those observed in connection (1°) with every observation of the Moon for absolute longitude; (2°) with chronometric differences of longitude; (3°) with the actual Transit of *Venus*.

The abstract of Table V. contains the Errors and Rates of the Transit Clock, the errors being corrected for the approximate values of the personal equations, assuming Mr. Sidgreaves (W S) as the standard. The clock's loss in 24 hours corresponds to the middle time between the two sets of observations from which it has been deduced; the *adopted rate* corresponds to the approximate sidereal time given. When the interval of time for which clock-rate has to be allowed in determining the sidereal time for any purpose exceeds six hours, the "loss in 24 hours" has been used as the rate.

For reasons before mentioned, the clock-error cannot be considered certain

when there has been an interval of several hours between the observations of the clock and circumpolar stars. The second place of decimals in the value of "Clock Slow" will generally have no significance.

The observers are indicated, where required, by the initials—

P - - -	Mr. Perry.
C - - -	Lieutenant Coke.
C C - - -	Lieutenant Corbet.
G - - -	Lieutenant Goodridge.
W S - -	Mr. Sidgreaves.
B S - - -	Mr. Smith.

RELATIVE PERSONAL EQUATIONS OF THE OBSERVERS.

Although there are not many observations of transits of stars by two observers on the same night, the steadiness of the clock-rate admits of approximate values of the relative personal equations being obtained by comparing one day with the next. Nearly the whole of the azimuths of the Moon were observed by Mr. Sidgreaves, with local time obtained by another observer with the transit instrument. Mr. Sidgreaves' custom of observing the azimuth of a star with every observation of azimuth of the Moon practically makes the latter independent of small errors in the local time; but as the habits of these observers appear to differ in a very unusual manner, the approximate differences have been investigated. In the following table the equation $P - G = +0^{s}\cdot06$ signifies that P makes the clock $0^{s}\cdot06$ more slow than does G. Every one of these determinations is affected by the uncertainty of the collimation zero, and nearly every one of them by uncertainty of the azimuth error. The second place of decimals must, of course, be regarded as of no significance.

Day.	Interval of Time between the Observations.	Observers and Excess of "Clock Slow."	Day.	Interval of Time between the Observations.	Observers and Excess of "Clock Slow."
1874.	h	s	1874.	h	s
Nov. 6	4	P − G = + 0·06	Nov. 17	24	P − BS = + 0·20
7	3	P − G = + ·49	18	4	BS − G = − ·08
12	$1\frac{1}{2}$	P − G = − ·21	18	24	BS − P = + ·10
15	1	WS − BS = + ·56	18	24	G − P = + ·20
16	2	WS − BS = + 0·20	19	1	WS − P = + 0·29

Day.	Interval of Time between the Observations.	Observers and Excess of "Clock Slow."	Day.	Interval of Time between the Observations.	Observers and Excess of "Clock Slow."
1874–5.	h	s	1874–5.	h	s
Nov. 19	$1\frac{1}{2}$	P − G = −0·39	Jan. 11	24	C − C C = +0·20
20	24	G − P = + ·30	12	24	C C − P = + ·40
22	2	W S − P = + ·27	25	18	C C − C = + ·30
Dec. 11	24	P − B S = + ·25	27	30	C − P = + ·10
15	4	W S − G = + ·23	Feb. 2	24	S − C C = + ·32
17	$2\frac{1}{2}$	W S − B = + ·47	7	24	C − P = + ·42
18	2	W S − G = + ·32	12	24	C C − P = + ·20
23	24	P − G = + ·20	12	24	C − P = + ·65
27	3	W S − P = + ·63	18	24	C C − P = + ·63
Jan. 3	24	C − G = + ·12	19	24	C − P = + ·30
10	24	C − C C = + ·35	20	24	C − P = + ·40
10	24	C C − P = +0·45	21	20	C C − C = +0·25

Adopting W S as the standard, the following values result:—

		s
P	=	+0·29
C	=	−0·10
C C	=	−0·10
G	=	+0·25
W S	=	0·00
B S	=	+0·44

which have been applied to the "Clock Slow" determined by observation, as given in Table V.

THE ALTAZIMUTH OBSERVATIONS.

The Altazimuth used at Observatory Bay was constructed expressly by Messrs. Troughton and Simms, and is a model of stability and good workmanship. It was intended to measure both azimuths and zenith distances. The rotating body of the instrument, including everything necessary for the measurement of zenith distances, is similar to the vertical circles used at Honolulu and Rodriguez (already fully described), with the addition of the four microscopes for reading the fixed horizontal circle, the arms supporting these being cast in one with the rotating body. The reticule contained five vertical and five horizontal wires of spider's web. The observed zenith distances being of stars for latitude, only the central horizontal wire was used. The upper zenith-distance level was graduated with 72 divisions, and

the lower with 60 divisions, to one minute of arc. The "Level Indication" is one-fourth of the sum of the four readings, diminished by one-twentieth of the sum of the readings of the upper level. Strictly, the diminution should have been one-twenty-fourth of the sum for the upper level; but the error has no appreciable effect upon the final latitude, the vertical axis being always within a few seconds of true perpendicularity. The level zero is included in the zenith point. The vertical circles are 14 inches in diameter, divided to 5′ spaces. Both pivots are pierced, to enable the instrument to be used with both positions of the horizontal axis in regard to its supports, but this entails the reversal of the levels and micrometers to make the direction of graduation accord with that on the circles.

The correction applied to the reading of the vertical circle for runs of the micrometers is shown in the following table:—

CORRECTION for RUNS of the MICROMETERS of the VERTICAL CIRCLE.

Day.	Correction for Runs for 100″.		Day.	Correction for Runs for 100″.	
	Observed.	Adopted.		Observed.	Adopted.
1874–5.	″	″	1875.	″	″
Nov. 22	+ 1·30		Jan. 27	...	+ 0·50
24	+ 0·90	+ 1·04	28	...	
24	+ 0·93		Feb. 3	+ 0·20	+ 0·44
26	+ 0·08	− 0·22	3	+ 0·68	
26	− 0·53		5	...	+ 0·30
27	+ 1·20	+ 1·00	7	...	
27	+ 0·80		8	− 0·10	
Dec. 3	...	+ 0·65	8	+ 0·32	
27	...		12	+ 0·55	+ 0·09
31	+ 0·45	+ 0·30	12	− 0·42	
31	+ 0·15		13	...	+ 0·46
Jan. 3	+ 1·65	+ 1·64	14	+ 0·88	+ 0·85
3	+ 1·63		14	+ 0·83	
5	+ 0·43	+ 0·54	17	− 0·27	− 0·30
5	+ 0·65		17	− 0·33	
13	+ 1·28		18	...	0·00
13	+ 1·35	+ 1·15	21	+ 0·62	+ 0·68
25	+ 1·18		21	+ 0·73	
25	+ 0·80				

The stars selected for the determination of co-latitude were such as had been well observed in N.P.D. at Greenwich, Melbourne, or the Cape of Good Hope. For stars South of the equator the N.P. Distances of the southern

observatories have been used. The reductions from mean to apparent places have been taken from the *Nautical Almanac* for all stars found in that work.

The refractions have been computed by the tables forming the Appendix to the *Greenwich Observations* for 1853, and then reduced in the proportion of 1 to 0·9947. Whether this reduction was proper or not is of little importance, as stars were observed North and South of the zenith.

An aneroid barometer, suspended in the Altazimuth observatory, was read in connection with the zenith distance observations; in addition to which a mercurial barometer, Adie M 33, properly tested before leaving England, was suspended in the observer's dwelling-house, and read every four hours. These readings generally afford the means of ascertaining the error of the aneroid with sufficient accuracy, as shown by the following table:—

Month.	Number of Comparisons.	Correction to Aneroid.
		in.
1874, April	8	−0·29
,, November	14	−0·34
,, December	4	−0·31
1875, January	9	−0·29
,, February	16	−0·32

The correction $-0^{in}\cdot32$ has been applied throughout.

From the observations (of which it is unnecessary to print the details) we have the following result for the co-latitude of the Altazimuth pier at Observatory Bay:—

		° ′ ″
By 26 stars North of zenith,	co-latitude is	40. 34. 48·2 S.
,, 8 ,, South ,,	,,	40. 34. 48·0 S.

Adopted latitude... 49°. 25′. 11″·9 S.

OBSERVATIONS OF AZIMUTH.

The horizontal circle, 15 inches in diameter, fixed upon the tripod stand, is divided into spaces of 5′, and is read by the four microscope-micrometers attached to the revolving body. It was intended that a revolution of the screw of each micrometer should be one minute, and the screw-heads were divided on silver into 60 parts or seconds. The stationary portion of the

body of the instrument, consisting of the vertical axis, the horizontal circle, and the tripod stand, was undisturbed during the series of observations, except by occasional adjustments of the foot screws, each of which rested in a radial groove cut on the surface of a brass plate, which was countersunk in the circular slab of slate that was cemented to and formed the top of the pier. The delicacy of the levels used with the instrument made it imperative to preserve the vertical axis within a few seconds of true perpendicularity. The pier seems to have undergone but little or no settlement.

The runs of the micrometers of the horizontal circle were observed as follows, chiefly by Mr. Sidgreaves:—

CORRECTION for RUNS of the MICROMETERS of the HORIZONTAL CIRCLE.

Date.	Correction for Runs for 100″.		Date.	Correction for Runs for 100″.	
	Observed.	Adopted.		Observed.	Adopted.
1874–5.	″	″	1875.	″	″
Nov. 15	+ 0·68		Jan. 13	+ 0·95	
15	+ 0·52		13	+ 0·58	+ 0·81
17	+ 0·53		22	+ 1·17	
17	− 0·45		22	+ 0·52	
18	+ 0·78		23	+ 0·50	
18	− 0·50		23	0·00	
19	− 0·02		26	+ 0·12	
19	+ 0·05	+ 0·19	26	+ 0·15	
22	+ 1·05		27	+ 0·72	+ 0·23
24	− 0·28		27	− 0·05	
26	− 0·27		29	+ 0·53	
26	+ 0·25		29	− 0·15	
30	+ 0·47		Feb. 8	− 0·22	
30	− 0·15		8	− 0·45	− 0·24
Dec. 17	− 0·20		11	− 0·05	
17	+ 0·05		11	− 0·22	
24	+ 0·07		12	+ 0·30	
24	+ 0·02		12	+ 0·15	
28	+ 0·17	+ 0·11	14	+ 0·18	
Jan. 8	+ 0·45		14	+ 0·22	+ 0·24
8	− 0·02		21	+ 0·60	
10	+ 0·38		21	− 0·03	
10	+ 0·10				

The horizontal intervals of the vertical wires were determined by Mr. Sidgreaves as follows:—

1874, 1875.	Number of Determinations.	Distance from the Center Wire.			
		Wire I.	Wire II.	Wire IV.	Wire V.
		′ ″	′ ″	′ ″	′ ″
Nov. 15 to Dec. 3	14	+ 7. 37·9	+ 3. 56·4	− 3. 47·2	− 8. 2·8
Dec. 27 to Jan. 1	10	+ 7. 44·9	+ 3. 48·0	− 3. 49·9	− 8. 4·4
Jan. 13 to Feb. 13	10	+ 7. 46·5	+ 3. 48·1	− 3. 48·3	− 8. 3·5

A new set of wires was inserted on December 23.

The intervals of the wires from the mean wire employed in the reduction of imperfect transits are :—

	From Nov. 15 to Dec. 22.	From Dec. 23 to end.
	′ ″	′ ″
Wire I.	+ 7. 41·0	+ 7. 49·6
,, II.	+ 3. 59·5	+ 3. 52·0
,, III.	+ 0. 3·1	+ 0. 3·9
,, IV.	− 3. 44·1	− 3. 45·2
,, V.	− 7. 59·7	− 8. 0·0

When the wires were brought in succession, in the order above given, upon the distant azimuth mark, the lamp being to the observer's right hand, the circle-reading increased. In the same position of the instrument, the Moon passed the wires in the same order.

The *Correction for Collimation* is referred, for convenience, to the mean of the wires. It has been deduced from all the observations of stars on the five wires, as well as from those of the distant mark by the center wire only, the results being given in Table I. No explanation can be given of the systematic difference in the collimation corrections obtained by the two methods,* nor of the sudden change on November 27. On that day carpenters were employed in the hut for some alterations.

The *Error of Level* of the horizontal axis was determined with a striding

* The intervals of the wires from the center wire were determined with such accuracy that some other reason for the discordance must exist.

spirit-level at every observation of azimuth. The value of the graduations engraved on the glass bubble, determined by the makers, was 60 to one minute of arc. The *Error of Level* is corrected for the inequality of the pivots of the horizontal axis. This inequality was determined by Mr. Sidgreaves, by reversing the axis eight times on 1875, January 2, to be $0''\cdot52$, and by an equal number of reversions on January 5, $0''\cdot48$, the smaller pivot being on the same side as the lamp. The correction applied to the level-error on this account is $0''\cdot50$, positive with lamp left, negative with lamp right.

Mr. Sidgreaves, by a number of suitable levellings, determined that the pillar supporting the axis on the lamp side was shorter than the pillar on the side of the micrometers by 0·00030 of an inch, causing a constant difference in the level-error lamp R. and lamp L. of $12''\cdot6$, a circumstance which caused much trouble when observing with the instrument. After leaving the makers' hands it had been carelessly taken to pieces.

Nearly the whole of the observations of the Moon in azimuth, for the determination of the longitude of the station, were made by Mr. Sidgreaves, who, whenever possible, made one or more observations of stars with large zenith distances. The *local sidereal time* determined by one observer with the transit instrument was transferred to the Altazimuth-clock, and used generally for the azimuth observations by another observer; but the adoption of a zero of azimuth determined by a star at the same time and with the same clock-error practically eliminates a systematic error that might thus arise, and the observations become strictly differential.

The azimuth observations of the Moon should be divided into two classes—those accompanied by a star, and those without. The former present no difficulty; the zero of azimuth derived from the star (or stars) by an observer is applied to his observations of the Moon, thus eliminating systematic error. In the treatment of the latter class, which cannot be made perfectly satisfactory, the observations of the distant azimuth-mark have been taken as affording the best zero of azimuth obtainable; the absolute azimuth of the mark being taken as $235°.\ 41'.\ 8''\cdot7$, which is the mean of 23 determinations. The distant mark was a sharply-defined edge of rock projected against the sky. It was always observed by Mr. Sidgreaves himself.

The horizontal transits of the Moon and stars were taken over the middle

portion of each wire, the zenith distance slow-motion-screw being turned as requisite, and the times being recorded by the Altazimuth-clock. The microscopes of the horizontal circle were then read, and the striding level applied. The Altazimuth-clock was made by E. Dent, of London; the pendulum-rod was of wood. The clock was compared with the Transit-clock by the intervention of a solar half-seconds chronometer at instants when the beats coincided.

For imperfect transits over the five vertical wires a correction has been applied to the circle-reading, equal to the distance of the mean of the wires observed from the mean of the five, multiplied by the cosecant of the apparent zenith distance; and the same factor corrects the collimation. The correction to the circle-reading for level-error is the level-error multiplied by the cotangent of the zenith distance.

The Greenwich mean solar time, corresponding to the local sidereal time of each observation (obtained by applying the Altazimuth-clock correction to the clock-time of transit) has been computed on the two assumptions of east longitude $4^{h}. 39^{m}. 0^{s}\cdot0$ and $4^{h}. 49^{m}. 0^{s}\cdot0$. For each of these Greenwich mean times the Moon's Geocentric Right Ascension, North Polar Distance, Equatorial Horizontal Parallax, and Semidiameter, have been interpolated with second differences from the hourly ephemeris in the *Nautical Almanac.*

The tabular azimuth of the Moon's limb has then been computed in the following manner:—

The logarithm of the distance from the center of the earth to the point where the normal of Observatory Bay intersects the axis of the earth, called the axial distance of the normal-center, has been taken as 7·7046.

The correction to be applied to the Geocentric S.P.D. to obtain the Normal-centric S.P.D. has been computed from the formula—

Correction (always negative) = seconds of equatorial horizontal parallax
× sine Geocentric S.P.D. of center
× axial distance of normal center.

The tabular azimuth of the limb, and the tabular zenith distance, are thus computed:—

If a great circle passing through the center of the Moon intersect the meridian at right angles, and the arc of the meridian between the points of

intersection and the Pole be called β, then, γ being the astronomical co-latitude,—

$$\tan \beta = \cos \text{hour-angle} \times \tan \text{Normal-centric S.P.D.},$$

$$\tan \text{azimuth of center} = \frac{\tan \text{hour-angle} \times \sin \beta}{\sin (\beta - \gamma)},$$

$$\cot \text{zen. dist. of center} = \cot (\beta - \gamma) \, . \cos \text{azimuth}.$$

The approximate apparent zenith distance, column 7, has been obtained by adding, to the Z.D. thus found, the approximate parallax in Z.D. taken from Table 39 of Raper's *Navigation.*

The azimuths are reckoned from South through West to 360°.

The azimuthal semidiameter, to be applied to the above azimuth of the center to obtain that of the limb, is found by multiplying the geocentric semidiameter (in seconds of arc) by the cosecant of the tabular normal-centric zenith distance of the center. The small correction required to reduce the geocentric semidiameter to the normal-centric diameter has generally been taken into account, although its greatest value is 0″·1.

If a_1, a_2 be the two tabular azimuths of the limb, corresponding to the first and second assumptions of longitude respectively, and a_0 be the observed azimuth, the longitude inferred from each observation is—

$$4^h. \, 39^m. \, 0^s{\cdot}0 + \frac{60^s \times (a_1 - a_0)}{a_1 - a_2}.$$

The details of the extensive calculations are suppressed, for the same reason which applied to those of the Altazimuth Zenith Distances at Rodriguez.

ON THE LONGITUDE OF OBSERVATORY BAY.

(1.) *Longitude of Observatory Bay from the observed Right Ascension of the Moon on the Meridian.*

In Table IV. are given the transits of the Moon as observed. The incomplete transits have been reduced as described in Part I., page 22. In Table VI. the longitude is computed from each observation, except a few when the clock and instrumental errors cannot be inferred with safety. The weights assigned are proportional to the square of the change of R.A. in 1^s, reduced in certain cases.

The longitude of the transit pier is obtained as follows:—

Observer.	☽ I.	Number of Obs.	☽ II.	Number of Obs.	Mean.	Final Weight.
	s		s		h m s	
Coke	37·25	3	30·97	3	4. 39. 34·1	1
Corbet	46·06	2	23·11	2	4. 39. 34·6	1
Perry	32·75	3	24·8	1	4. 39. 28·8	½
Sidgreaves	..	0	28·5	1	...	
Goodridge	..	0	34·65	2	...	
Smith	25·1	1	..	0	...	
				Mean	4. 39. 33·2	

It will be remarked that three of the observers have observed only one limb of the Moon. The case of Corbet shows how unsafe it would be to give any weight to observations of one limb only. Hence the final longitude by this method is made to depend upon three observers only.

(2.) *Longitude of Observatory Bay from the observed Azimuths of the Moon.*

These observations must be divided into two classes—those when a star has been observed with the Moon, Class A., and those when no star was observed, Class B. When the extreme instability of the transit instrument in collimation and azimuth is considered, but little weight can be given to the observations of Class B. The longitude by Altazimuth therefore depends entirely upon Mr. Sidgreaves, for he alone observed both limbs of the Moon.

Thus we have, Class A., observer W S—

	h m s
By ☽ I., 18 sets of observations, longitude	4. 39. 35·26
By ☽ II., 10 ,, ,, ...	4. 39. 32·54
Mean	4. 39. 33·9 East of Greenwich.

(3.) *Longitude of Observatory Bay from the observed Occultation of* 9 *Tauri by the Moon,* 1874, *December* 20.

The observation was made by W S with the 6-inch Equatorial.

The star disappeared at the Moon's dark limb, at $5^h. 11^m. 0^s{\cdot}5$ by the Equatorial-clock.

The following comparisons were then made:—

	h m s	h m s
Chronometer Frodsham 3178	11. 21. 40·5	11. 36. 50·0
Equatorial-clock	5. 17. 23·0	5. 32. 35·0
Chronometer Frodsham 3178	11. 26. 15·5	11. 29. 15·0
Transit-clock..................	5. 22. 41·0	5. 25. 41·0

With the Error and Rate of the Transit-clock in Table V., the Equatorial-clock is inferred to be 1^m. $12^s{\cdot}76$ slow on local sidereal time. Hence we have:—

Local sidereal time of disappearance	5^h. 12^m. $13^s{\cdot}26$
Assumed corrections—	
to the Moon's Tabular Geocentric R.A..........	$-0^s{\cdot}55$
,, ,, ,, N.P.D........	$-1''{\cdot}7$
to the horizontal parallax for latitude	$-6''{\cdot}96$
to the semidiameter (Breen's correction)	$-2''{\cdot}00$
Augmentation of the semidiameter	$+4''{\cdot}50$

For the mean place of 9 Tauri for 1874·0—

Greenwich Catalogue for 1864—

R.A. 3^h. 29^m. $33^s{\cdot}59$ (4 obs.) N.P.D. 67°. 12′. 27″·4 (4 obs.)

Greenwich Catalogue for 1872—

R.A. 3^h. 29^m. $33^s{\cdot}57$ (3 obs.) N.P.D. 67°. 12′. 27″·0 (2 obs.)

Reduction to apparent place, 1874, December 20 ..... $+4^s{\cdot}00$ $-21''{\cdot}3$

Adopted apparent place of 9 Tauri—

R.A. 3^h. 29^m. $37^s{\cdot}58$ N.P.D. 67°. 12′. 5″·9.

Assumed astronomical co-latitude .... 40°. 34′. 48″·1 S.

	h m s	h m s
Assumed East longitudes..................	4. 39. 24·00	4. 39. 44·00
Greenwich Mean Times, December 20	6. 36. 7·83	6. 35. 47·88
Apparent R.A. of Moon's center	3. 28. 46·06	3. 28. 45·21
	° ′ ″	° ′ ″
,, N.P.D. ,, ...	67. 23. 24·9	67. 23. 28·8
	′ ″	′ ″
Distance of star from Moon's center.........	16. 24·53	16. 35·73
Moon's augmented semidiameter	16. 31·11	16. 31·11

Inferred longitude East of Greenwich... 4^h. 39^m. $35^s{\cdot}8$.

The occultation of 9 Tauri was also observed at the American Station at Molloy Point. Professor S. Newcomb kindly communicates that the longitude of Molloy Point inferred from the occultation is—

4^h. 40^m. $21^s{\cdot}7$ East of Greenwich.

For the difference of longitude between Molloy Point and Observatory Bay we have the following :—

	Molloy Point, East of Observatory Bay.	
	m s	
By chronometers in the *Gazelle*	0. 47·4	(Auwers).
By chronometers in the *Volage*	0. 46·9	*See* next section.
Again by chronometers in the *Volage* .	0. 46·3	
By rocket signals	0. 47·2	
Mean	0. 46·95	

The same occultation was also observed at the German Station at Betsy Cove, Kerguelen's Island. Professor A. Auwers kindly communicates the following, by letter dated 1879, October 18 :—

"From the occultation of 9 Tauri, 1874, December 20 (good observations, two observers)—

"Longitude of Betsy Cove, East of Greenwich, $4^{h}. 40^{m}. 43^{s}\cdot2$; with mean error, $\pm 2^{s}\cdot6$.

"I have computed this occultation with Newcomb's corrections to Hansen's Tables, modified so as to agree with the Luxor occultations.* The mean error has been found, supposing the mean error of each relative co-ordinate to be $\pm 1''\cdot5$."

The last occultations observed at Luxor were on 1874, December 15, only five days before the Kerguelen occultation; and, the longitude of Luxor having been obtained by telegraphic signals with Mokattam, it may be supposed that Dr. Auwers' reduction of the occultations is the most free from systematic errors.

The difference of longitude between Betsy Cove and Observatory Bay was found as follows :—

	Betsy Cove, East of Observatory Bay.	
	m s	
By chronometers in the *Gazelle*.....	1. 11·55	(Auwers).
By chronometers in the *Volage*	1. 11·01	(Auwers).
Again by chronometers in the *Volage*	1. 10·72	(Corbet).
Adopted	1. 11·19	(Auwers).

* Beobachtung des Venus-Durchgangs von 8 December 1874, in Luxor, von A. Auwers. Berlin, 1878, page 122.

We have, therefore, the three following determinations of the longitude of Observatory Bay, as inferred from the occultation of 9 Tauri :—

	h m s
From the Betsy Cove observation........	4. 39. 32·0
,, Molloy Point ,, ...	4. 39. 34·75
,, Observatory Bay observation ...	4. 39. 35·8
Mean, giving double weight to the Betsy Cove result	4. 39. 33·6

The circumstances of the occultation were very favourable, as the center of the Moon passed within 6′ of the star.

(4.) *Longitude of Observatory Bay from the Lunar Observations at Betsy Cove. Communicated by Dr. Auwers.*

Observer.	Instrument.	☽ I.		☽ II.		Mean. Betsy Cove, West of Greenwich.
		s		s		h m s
Weinere	Transit	45·56	21·5	43·41	23·6	4. 40. 44·48
Börgen	Altaz.	48·45	16·8	43·38	6·7	4. 40. 45·92
					Adopted...........	4. 40. 44·91 ± 1s·54.

Applying the difference of longitude as before, we have for the longitude of Observatory Bay from these observations—

$4^{h}. 39^{m}. 33^{s}·72.$

The corrections applied to the Moon's Tabular Right Ascension were the same as those used in reducing the transit-observations at Observatory Bay.

We have, therefore, the following results for the longitude of the transit instrument at Observatory Bay :—

	h m s
By the Meridional transits at Observatory Bay (3 observers)...	4. 39. 33·2 E.
,, Altazimuth observations ,, (1 observer) ...	4. 39. 33·9
,, Occultation of 9 Tauri ,, (4 observers)...	4. 39. 33·6
,, Meridional and Altazimuth observations at Betsy Cove (2 observers)...	4. 39. 33·7
Adopted	4. 39. 33·5

It seems highly improbable that the error of this determination can exceed 2s.

G. L. T.

OBSERVATIONS of the TRANSIT of VENUS, 1874, December 8, by the Reverend S. J. PERRY, with the 6-inch Equatorial.

The double-image micrometer, with power slightly over 150, with an achromatised wedge of dark glass—and the negative eye-piece, power 150, with two dark glasses—were conveniently placed; and two other wedges of neutral-tint glass—one very light, the other dark—were at hand in case of need.

The driving-clock of the Equatorial being very inferior, and having no efficient regulating gear, it was necessary to add a new driving power to assist the clock, and to fit a regulating rope to the new driving weight. This was done very effectively by the Rev. W. Sidgreaves.

Lieutenant Gamble, R.N., arrived from H.M.S. *Volage* at 6 a.m., and we at once examined the time required for altering eye-pieces, focussing, &c.; this was about 30^s.

The morn had been very fine, but the clouds were thickening fast. Unfortunately a dense cloud settled just over the Sun for about 20 minutes, and there was scarcely a breath of wind to move it.

It was impossible to use the double-image micrometer until Venus was well on the disk, and even then the images were faint without any dark glass.* The wind was rising, and this, combined with the faintness of the light through the clouds, rendered the use of the micrometer at Egress quite out of question.

The times given below are those given by Dent 2011 uncorrected :—

$12^h. 0^m. 56^s\cdot5$. Venus half on the disk; solar prism and negative eye-piece, power 150.

$15^h. 40^m. 38^s\cdot8$. A good geometrical contact; solar prism, power 150; no dark glass. There was no appearance of black drop before contact, but this might have been due to the obscuring clouds.

* The few micrometer readings obtained cannot be utilized.

I tried the micrometer again for the measurement of cusps, but the light was too faint.

$15^{h}.\ 56^{m}.\ 3^{s}.$ Venus half off the disk. Solar prism, power 150; the light end of the neutral-glass wedge used. The limb of the Sun was very well defined, and the limb of Venus did not appear to be irregular.

$16^{h}.\ 11^{m}.\ 25^{s}\cdot 8.$ External contact; solar prism, power 150. Possibly a little too early.

S. J. PERRY.

COMPARISONS of the CLOCK *Dent* 2011 with the TRANSIT-CLOCK, by the intervention of the MEAN SOLAR HALF-SECONDS CHRONOMETER *Frodsham* 3178; 1874, December 8.

Time by Transit-Clock at Comparison with Chronometer.	Time by Frodsham 3178.		Time by Dent 2011 at Comparison with Chronometer.	Inferred Dent 2011 Slow on Local Sidereal Time.
	At Comparison with Transit-Clock.	At Comparison with Dent 2011.		
h m s	h m s	h m s	h m s	m s
9. 51. 51·0	4. 42. 4·5	4. 51. 57·0	10. 1. 27·0	+ 1. 10·94
10. 10. 30·0	5. 0. 40·5	5. 4. 3·0	10. 13. 35·0	1. 10·91
16. 30. 30·0	11. 19. 39·0	11. 23. 10·0	16. 33. 44·0	1. 11·28
16. 43. 10·0	11. 32. 17·0	11. 35. 48·0	16. 46. 24·0	+ 1. 11·34

OBSERVATIONS of the TRANSIT of VENUS, 1874, December 8, by the Reverend W. SIDGREAVES.

The instrument used by Mr. W. Sidgreaves was achromatic, of 4 inches aperture, kindly lent by the Royal Astronomical Society. It was equatorially mounted upon a tripod stand; slow motion in R.A. was effected by a handle and Hook's joint. It was fitted with a solar diagonal reflecting prism.

Time was recorded by Lieutenant T. G. FENN, of H.M.S. *Volage*, from the Solar Chronometer *Appleton* 195.

Nothing was seen of the *Ingress*.

Egress.

Time by Appleton 195.	
h m s	
22. 27. 42·8.	Geometrical contact. Scarcely visible through cloud. Very uncertain judgment. Eye-piece, power 150 used; without a coloured glass.
22. 43. 42·5.	A guess at the time of transit of the center of the planet over the Sun's limb. Image faint, but brighter than before. Without a coloured glass.
22. 58. 19·2.	External contact. Without a coloured glass. Image bright, through haze. I think I got it fairly exact.

W. SIDGREAVES.

COMPARISONS of the CHRONOMETER *Appleton* 195 with the TRANSIT-CLOCK at OBSERVATORY BAY, 1874, December 8.

Time by Transit-Clock.	Transit-Clock Slow.	Time by Appleton 195.	Appleton 195 Slow on Local Mean Solar Time.	Hourly Losing Rate.
h m s	s	h m	m s	s
9. 53. 43·0	+ 52·82	16. 41. 45·0	+ 2. 34·12	
10. 7. 35·0	52·85	16. 55. 35·0	+ 2. 33·87	+ 0·36
16. 25. 29·0	53·68	23. 12. 25·5	+ 2. 36·28	
16. 38. 9·0	+ 53·71	23. 25. 3·2*	+ 2. 36·24	

* Assumed to be $23^h. 25^m. 3^s{\cdot}5$.

For Mr. Perry's observations of Egress we have the following results, assuming the Latitude 49°. 25′. 11″·9 S., Longitude $4^h. 39^m. 33^s{\cdot}5$ East of Greenwich :—

Phenomenon observed.	Recorded Time by Dent 2011.	Dent 2011 Slow.	Local Sidereal Time.	Greenwich Sidereal Time.	Local Tabular Distance of Centers of Sun and Venus.
EGRESS.	h m s	m s	h m s	h m s	′ ″
Internal "Geometrical" Contact	15. 40. 38·8	+ 1. 11·3	15. 41. 50·1	11. 2. 16·6	15. 41·72
External Contact "probably early"	16. 11. 25·8	+ 1. 11·3	16. 12. 37·1	11. 33. 3·6	16. 45·80

Taking $R = 976''{\cdot}82$, $r = 31''{\cdot}42$, and mean solar parallax $= 8''{\cdot}950 \times \left(1 + \frac{n}{100}\right)$, we have the equations—

For Internal "Geometrical" Contact—

$$+3''{\cdot}68 = +0''{\cdot}1004\, n - {\cdot}1969\, \delta\, \text{R.A.} - {\cdot}9772\, \delta\, \text{N.P.D.} + 0''{\cdot}0309\, \delta t - \delta R + \delta r,$$

and for External Contact—

$$+2''{\cdot}44 = +0''{\cdot}0953\, n - {\cdot}2983\, \delta\, \text{R.A.} - {\cdot}9463\, \delta\, \text{N.P.D.} + 0''{\cdot}0376\, \delta t - \delta R - \delta r.$$

For Mr. Sidgreaves' observations are obtained the following results :—

Phenomenon observed.	Recorded Time by Appleton 195.	Local Mean Solar Time.	Local Sidereal Time.	Greenwich Sidereal Time.	Local Tabular Distance of Centers of Sun and Venus.
EGRESS.	h m s	h m s	h m s	h m s	′ ″
Internal "Geometrical" Contact -	22. 27. 42·8	22. 30. 18·85	15. 41. 32·39	11. 1. 58·89	15. 41·16
External Contact -	22. 58. 19·2	23. 0. 55·43	16. 12. 14·01	11. 32. 40·51	16. 44·88

Whence the final equations—

For Internal "Geometrical" Contact—

$$+4''{\cdot}24 = +0''{\cdot}1006\, n - {\cdot}1959\, \delta\, \text{R.A.} - {\cdot}9772\, \delta\, \text{N.P.D.} + 0''{\cdot}0317\, \delta t - \delta R + \delta r,$$

and for External Contact—

$$+3''{\cdot}36 = +0''{\cdot}0954\, n - {\cdot}2972\, \delta\, \text{R.A.} - {\cdot}9467\, \delta\, \text{N.P.D.} + 0''{\cdot}0372\, \delta t - \delta R - \delta r.$$

G. L. T.

OBSERVATIONS

AT

OBSERVATORY BAY, KERGUELEN ISLAND,

IN TABULAR ARRANGEMENT.

TABLE I.—COLLIMATION of the TRANSIT INSTRUMENT by REVERSAL on the NORTH DISTANT MARK.

1874, Local Mean Time.	Position and Reading of the Micrometer.	Zero of Collimation.
h	r	r
November 16	....	[20·549]
17	....	[20·549]
19, 7	E. 20·811	20·550
	W. 20·288	
20	W. 20·001	
	E. 21·129	20·566
	W. 20·006	
23	....	[20·522]
24, 10	z Octantis S.P.	20·513
25	W. 20·771	
	E. 20·370	20·571
	W. 20·772	
December 4	W. 20·837	20·586
	E. 20·357	
7	....	[20·572]
8	....	[20·568]
10	....	[20·558]
11	....	[20·553]
15	....	[20·532]
16, 22½	E. 19·688	
	W. 21·366	[20·527]
	E. 19·689	
17, 7½	W. 21·358	[20·527]
	E. 19·684	
18, 7	W. 21·309 *	
	E. 19·757	[20·530]
	W. 21·303	
18, 7	W. 19·891 †	
	E. 21·175	20·528
	W. 19·873	
20, 1	W. 21·649	
	E. 19·423	20·538
	W. 21·658	[20·555]

1874, Local Mean Time.	Position and Reading of the Micrometer.	Zero of Collimation.
h	r	r
December 20, 7½	W. 21·709	
	E. 19·384	20·545
	W. 21·703	
20, 15½	W. 21·751	
	E. 19·404	20·579
	W. 21·758	[20·555]
22, 2	W. 21·704	
	E. 19·426	[20·563]
	W. 21·710	
22, 6	§ W. 21·290	
	E. 19·841	20·564
	W. 21·283	
24, 6	W. 21·251	
	E. 19·876	[20·565]
	W. 21·257	
27, 17	W. 20·927	
	E. 20·203	20·562
	W. 20·913	[20·567]
28, 6½	W. 20·938	20·563
	E. 20·189	
	E. 20·170	20·556
	W. 20·943	
31, 8	W. 21·288	
	E. 19·903	20·591
	W. 21·271	[20·576]
31, 12	W. 20·527	20·567
	E. 20·607 ‡	
	E. 20·619	20·570
	W. 20·522	
1875. January 9	W. 21·354	
	E. 19·696	20·532
	W. 21·383	
10	W. 21·349	20·574
	E. 19·800	

* "Mark at present used for Azimuth."
† "Another mark.'

§ December 22, 6h. Moved the East Pivot towards the South.
‡ Image of wires reflected from mercury.

Table I.—Collimation of the Transit Instrument—*continued.*

1875, Local Mean Time.	Position and Reading of the Micrometer.	Zero of Collimation.
h	r	r
January 12	W. 21·309 *	20·569
	E. 19·830	
16	W. 21·086	
	E. 20·043	20·561
	W. 21·073	
17	W. 21·104	
	E. 20·029	20·520
	W. 21·077	[20·558]
22 †	W. 21·089	
	E. 20·067	[20·576]
	W. 21·062	
23	W. 21·100	
	E. 20·087	20·584
	W. 21·063	[20·579]
26	W. 21·111	
	E. 20·072	[20·587]
	W. 21·092	
27	W. 21·036	
	E. 20·169	20·597
	W. 21·016	
27, 11½	W. 20·529 ‡	
	E. 20·639	[20·590]
	W. 20·531	
29	W. 21·046	
	E. 20·135	[20·588]
	W. 21·048	
February 8, 6	W. 21·048	
	E. 20·149	20·598
	W. 21·048	
February 8, 13	W. 20·539	
	E. 20·645 ‡	20·595
	W. 20·554	
9, 6½	W. 20·115 §	
	E. 20·051	(20·084)
	W. 20·118	[20·595]
11	W. 21·597	
	E. 19·593	[20·592]
	W. 21·593	
11, 10	W. 20·500	
	E. 20·707 ‡	20·601
	W. 20·492	
12, 8½	W. 21·503	
	E. 19·683	[20·589]
	W. 21·478	
13	W. 21·339	
	E. 19·839	[20·586]
	W. 21·296	
14	W. 21·440	
	E. 19·742	[20·583]
	W. 21·407	
14	W. 20·510	
	E. 20·649 ‡	20·584
	W. 20·527	
17	W. 21·196	
	E. 19·999	[20·591]
	W. 21·187	
18	....	[20·593]
19	...	[20·597]
21	....	[20·602]

* January 12. Daylight; misty.
† January 22. Evening. January 27. Evening.
‡ Image of wires reflected from mercury.
§ February 9. Probably W. 21·115.

Table I.—Collimation of the Transit Instrument—*concluded.*

1875, Local Mean Time.	Position and Reading of the Micrometer.	Zero of Collimation.	1875, Local Mean Time.	Position and Reading of the Micrometer.	Zero of Collimation.
h	r	r	h	r	r
February 23, 2½	W. 21·677	[20·609]	February 25 †	W. 20·236 §	
	*			E. 19·999	(20·138)
23, 2½	W. 21·290			W. 20·179	
23 †	W. 21·322				
	E. 19·921	[20·609]	26	....	[20·605]
	W. 21·273				

* February 23, 2½h. The Level and Azimuth were adjusted. † Evening.
§ Probably W. 21·236.

TABLE II.—LEVEL ERROR of the TRANSIT INSTRUMENT at OBSERVATORY BAY, determined by SPIRIT LEVEL.

[The sign + indicates that the East Pivot is low.]

Day.	Sidereal Time of Level Determination.	Level Error corrected for Inequality of Pivots.	Day.	Sidereal Time of Level Determination.	Level Error corrected for Inequality of Pivots.
1874.	h m	"	1874.	h m	"
November 15	5. 10	+ 6·12	November 18	2. 12	+ 5·02
	5. 30	+ 6·19		2. 25	+ 4·28
	5. 50	+ 5·26		2. 35	+ 1·24
	6. 20	+ 6·34		3. 0	+ 3·72
	6. 32	+ 5·56		3. 10	+ 5·14
	6. 40	+ 6·08		6. 40	+ 5·03
	6. 55	+ 6·64		7. 0	+ 4·77
	7. 0	+ 6·23	19	23. 0	+ 4·39
16	21. 25	+ 7·62		4. 0	+ 3·53
	1. 36	+ 5·97		4. 10	+ 3·27
	2. 0	+ 6·27		4. 25	+ 3·42
	2. 12	+ 6·76		5. 0	+ 2·74
	3. 0	+ 6·16		5. 20	+ 3·27
	3. 6	+ 5·48		5. 55	+ 3·34
	6. 0	+ 5·77		6. 20	+ 3·46
17	22. 20	+ 8·44		6. 40	+ 3·19
	3. 10	+ 8·93		7. 0	+ 3·36
	4. 5	+ 8·22	20	0. 15	+ 4·17
	5. 0	+ 7·77		0. 30	+ 5·74
	6. 40	+ 9·00		3. 0	+ 6·34

Table II.—Level Error of the Transit Instrument—*continued.*

Day.		Sidereal Time of Level Determination.	Level Error corrected for Inequality of Pivots.
1874.		h m	″
November	22	5. 10	+ 3·94
		5. 30	+ 3·72
		5. 50	+ 4·13
		6. 0	+ 2·82
		6. 20	+ 1·83
		7. 0	+ 3·53
		7. 15	+ 3·76
		7. 40	+ 3·00
	23	1. 20	+ 3·38
		1. 35	+ 3·72
		2. 5	+ 4·20
		2. 15	+ 4·17
		4. 40	+ 3·53
	24	1. 40	+ 5·33
		1. 50	+ 5·89
		2. 0	+ 5·97
		2. 10	+ 6·49
		2. 26 ?	+ 5·23
		2. 36	+ 2·42
	25	1. 20	+ 4·58
		1. 50	+ 4·73
		6. 10	+ 3·27
	26	1. 0	+ 6·38
		1. 28	+ 5·52
		1. 44	+ 6·19
		1. 59	+ 5·67
		2. 40	+ 5·82
		3. 0	+ 6·04
		6. 25	+ 4·69
	27	2. 15 ?	+ 4·06
		2. 36 ?	+ 1·53
		2. 50	+ 0·63
		3. 50	− 0·34
		4. 0	+ 0·97
		4. 15	+ 2·43
		4. 25	+ 0·89
		6. 40	+ 1·01
1874.		h m	″
November	30	6. 30	+ 2·47
		6. 35	+ 5·50
		7. 0	+ 3·22
		7. 5	+ 3·60
		7. 15	+ 5·63
		7. 35	+ 5·32
December	3	3. 0	+ 3·48
		3. 5	+ 3·90
		3. 45	+ 2·02
		4. 10	+ 3·32
	4	0. 50	+ 8·49
		1. 40	+ 7·58
	6	13. 20	+ 7·50
	7	5. 30	+ 6·76
		6. 0	+ 7·88
		16. 14	+ 10·80
		16. 39	+ 11·67
	8	23. 8	+ 11·07
		23. 40	+ 9·83
		23. 50	+ 9·76
		5. 43	+ 7·24
		5. 58	+ 7·17
		6. 25	+ 7·50
		6. 55	+ 7·39
		7. 5	+ 7·54
		7. 30	+ 7·32
		8. 20	+ 6·53
	10	3. 45	+ 10·27
		4. 15	+ 9·97
	11	6. 20	− 2·73
		7. 15	− 2·40
		8. 0	− 2·92
	12	2. 0	− 3·63
		2. 40	− 3·37
		2. 50	− 2·17

Table II.—Level Error of the Transit Instrument—*continued.*

Day.	Sidereal Time of Level Determination.	Level Error corrected for Inequality of Pivots.
1874.	h m	″
December 12	3. 0	− 2·21
	5. 0	− 3·60
	5. 15	− 2·21
	5. 30	− 3·74
	5. 45	− 1·87
15	1. 35	− 3·26
	2. 17	− 2·36
	3. 10	− 2·36
	3. 45	− 2·06
	5. 55	− 1·80
	6. 17	− 2·66
	6. 30	− 2·43
16	Noon	− 0·30
17	2. 50	+ 0·11
	3. 0	− 1·72
	3. 45	− 2·92
	4. 0	− 2·58
	5. 0	− 2·02
	5. 25	− 2·36
	5. 45	− 2·21
	6. 5	− 1·91
	6. 25	− 2·13
	6. 35	− 2·66
	7. 30	− 2·54
	8. 20	− 2·61
18	2. 45	− 0·33
	3. 7	− 0·78
	3. 30	− 0·48
	3. 47	− 0·41
	5. 0	− 0·26
	5. 15	− 0·22
	5. 25	− 0·41
	5. 45	− 0·26
	5. 55	− 0·22
	8. 20	− 1·56
	8. 25	− 1·56
1874.	h m	″
December 20	19·25	+ 0·60
	2·42	+ 1·24
	2·46	− 0·37
	3·10	+ 0·72
	3·58	+ 1·09
	4·15	+ 1·47
	4·40	+ 1·06
	5·40	+ 1·17
	5·55	+ 0·79
	6·28	+ 0·76
	6·50	+ 0·68
21	3. 0	+ 3·34
	4. 25	+ 2·93
	5. 20	+ 2·97
	6. 10	+ 2·29
[illegible]	....	− 2·09
	....	− 2·09
	5. 33	− 0·93
	7. 4	− 0·86
	7. 20	− 1·23
	7. 43	− 1·12
	8. 24	− 0·86
23	5. 45	+ 2·44
	6. 35	+ 1·50
24	2. 20	+ 2·82
	2. 40	+ 3·08
	2. 50	+ 3·60
	3. 35	+ 3·34
26	2. 59	0·00
	9. 50	− 0·85
27	5. 30	− 2·06
	5. 50	− 1·50
	7. 10	− 1·23
	7. 40	− 1·76

Table II.—Level Error of the Transit Instrument—*continued.*

Day.		Sidereal Time of Level Determination.	Level Error corrected for Inequality of Pivots.
		h m	″
1874. December	27	8. 20	− 2·17
		9. 50	− 2·51
		10. 20	− 2·28
		10. 44	− 2·66
	28	6. 30	− 2·28
		7. 10	− 2·21
		8. 25	− 2·12
	29	6. 40	− 2·66
		22. 0	− 1·91
	30	5. 35	− 1·87
		5. 50	− 2·36
		6. 18	− 2·40
		6. 30	− 2·24
		6. 55	− 2·28
		7. 0	− 2·20
		7. 25	− 2·20
		7. 45	− 0·86
	31	5. 0	− 1·68
		5. 10	− 1·80
		5. 20	− 2·06
		5. 30	− 1·64
		6. 20	− 2·21
1875. January	1	....	− 2·40
		....	− 2·84
	2	4. 10	− 2·32
		5. 35	− 5·51
		6. 10	− 6·71
		7. 50	− 4·57
	3	3. 45	− 0·18
		4. 10	− 0·78
		4. 30	− 0·93
		4. 55	− 1·57
		5. 13	− 1·53
		5. 35	− 1·76
		5. 55	− 1·87
		6. 35	− 1·12

Day.		Sidereal Time of Level Determination.	Level Error corrected for Inequality of Pivots.
		h m	″
1875. January	4	....	− 1·50
		....	− 1·38
	5	4. 0	− 1·42
		4. 35	− 2·06
		5. 3	− 0·86
		5. 50	− 1·23
		5. 55	− 1·57
		6. 20	− 1·57
	7	5. 20	− 1·01
		5. 30	− 0·86
	8	6. 35	− 0·35
		6. 55	− 0·60
		7. 40	− 1·01
		8. 0	− 1·27
		8. 15	− 0·82
	9	4. 30	+ 0·83
		5. 10	+ 1·62
		5. 40	+ 1·28
		6. 5	+ 0·38
	10	5. 5	+ 1·13
		5. 40	+ 1·92
		6. 10	+ 1·20
	11	6. 16	+ 1·24
		6. 40	+ 1·54
		7. 0	+ 2·03
		7. 30	+ 1·47
		7. 35	+ 1·54
		8. 10	+ 1·69
	12	6. 40	+ 3·27
		6. 55	+ 3·23
	13	0. 0	+ 4·24
		4. 40	+ 2·59
		5. 20	+ 2·52
		5. 50	+ 2·70
		6. 42	− 0·38

Table II.—Level Error of the Transit Instrument—*continued.*

Day.	Sidereal Time of Level Determination.	Level Error corrected for Inequality of Pivots.
1875.	h m	″
January 14	0. 40	+ 6·86
	0. 45	+ 10·38
16	7. 25	+ 7·57
	8. 20	+ 5·07
	9. 10	+ 5·52
	....	+ 6·72
	....	+ 6·79
17	3. 55	+ 7·88
	4. 5	+ 8·40
	4. 36	+ 6·76
	5. 5	+ 6·60
	5. 30	+ 6·00
	5. 50	+ 6·00
	6. 20	+ 6·00
18	....	+ 5·93
	....	+ 5·97
19	....	− 3·33
	....	− 3·07
20	....	− 4·34
	....	− 3·88
21	5. 20	− 2·81
	5. 50	− 2·62
	6. 59	− 2·77
	8. 20	− 5·21
	8. 40	− 4·64
22	9. 25	− 4·01
	9. 30	− 4·46
23	22. 55	− 4·46
	4. 30	− 2·51
	5. 10	− 3·74
	5. 50	− 3·56
	6. 15	− 3·03
	6. 45	− 3·82
	8. 0	− 3·56
	8. 20	− 2·13
	8. 50	− 2·96
1875.	h m	″
January 23	9. 50	− 3·37
	10. 10	− 3·52
	10. 20	− 3·56
	12. 20	− 3·78
25	8. 24	− 4·72
	8. 24	− 4·42
	12. 15	− 4·83
	12. 40	− 5·13
26	4. 30	− 4·83
	5. 25	− 4·23
	6. 0	− 4·38
	6. 25	− 3·26
	6. 42	− 2·10
	12. 5	− 3·00
	12. 15	− 3·78
	12. 40	− 3·03
	13. 20	− 2·81
27	7. 25	− 2·77
	7. 40	− 2·73
	9. 0	− 3·11
	9. 40	− 2·96
	13. 0	− 2·84
	13. 25	− 3·14
28	6. 0	− 3·41
29	5. 55	− 1·83
	6. 20	− 1·12
	6. 45	− 1·61
	7. 0	− 1·31
	14. 40	− 2·17
	15. 0	− 2·28
30	....	+ 0·04
	....	− 0·11
31	6. 43	− 1·46
	16. 0	− 1·01

Table II.—Level Error of the Transit Instrument—*continued.*

Day.	Sidereal Time of Level Determination.	Level Error corrected for Inequality of Pivots.
1875.	h m	″
February 2	6. 30	+ 1·60
	6. 45	+ 1·73
	7. 0	+ 1·69
3	5. 55	+ 2·97
	6. 25	+ 3·08
	6. 50	+ 4·39
	8. 15	+ 3·57
4	....	+ 5·22
	....	+ 5·48
5	5. 50	+ 6·49
	6. 5	+ 6·57
	6. 25	+ 3·52
	6. 45	+ 6·60
	7. 0	+ 6·04
6	7. 5	− 5·24
	8. 15	− 4·20
7	6. 20	− 4·31
	6. 45	− 4·64
	7. 0	− 4·72
	7. 30	− 4·46
	7. 40	− 3·00
8	8. 20	− 5·58
	8. 30	− 5·06
	9. 30	− 4·34
	9. 45	− 5·55
	10. 5	− 5·10
9	0. 5	− 7·64
	3. 47	− 5·88
	12. 30	− 5·56
10	....	− 6·97
	....	− 6·93
11	5. 45	− 7·38
	5. 55	− 7·04
	6. 20	− 7·04
	7. 0	− 7·01
1875.	h m	″
February 12	2. 45	− 3·62
	5. 50	− 5·96
	6. 20	− 5·58
	9. 0	− 5·70
13	3. 35	− 2·24
	3. 50	− 2·32
	5. 40	− 2·28
	5. 50	− 3·10
14	7. 5	− 3·48
	7. 40	− 3·77
	8. 15	− 2·58
	8. 45	− 3·48
15	5. 52	− 1·90
16	6. 0	− 0·92
	6. 15	− 1·67
17	6. 15	− 2·17
	7. 10	− 2·46
	7. 30	− 2·58
	7. 55	− 3·07
	8. 15	− 4·27
	8. 40	− 4·01
18	6. 40	− 1·42
	7. 15	− 2·39
	8. 15	− 1·08
	9. 0	− 1·38
19	8. 0	− 5·77
	8. 15	− 6·86
	8. 30	− 6·11
	8. 45	− 6·07
	9. 20	− 6·14
	9. 30	− 5·92
	9. 40	− 6·26
	10. 0	− 6·03
	10. 30	− 6·33

Table II.—Level Error of the Transit Instrument—*concluded.*

Day.	Sidereal Time of Level Determination.	Level Error corrected for Inequality of Pivots.
1875.	h m	″
February 20	6. 25	− 5·84
	6. 45	− 5·10
	10. 5	− 5·40
	10. 30	− 5·13
21	8. 15	− 5·58
	10. 15	− 5·24
	11. 35	− 5·70
22	6. 25	−10·50
	6. 45	−10·12
	7. 0	−10·23
	7. 10	−10·01
1875.	h m	″
February 23	0. 42	− 0·74
	13. 10	− 1·38
	14. 15	− 1·23
25	8. 30	− 0·97
	9. 20	− 0·30
26	10. 20	− 0·90
	14. 0	− 1·61
	14. 35	− 1·72
	16. 5	− 1·16

The Micrometer was West in every instance except the following :—

November 22, 6^{h}. 20^{m}.
November 24, 2^{h}. 36^{m}.

From November 27, 2^{h}. 36^{m}., to December 3, 4^{h}. 10^{m}.
December 10.

TABLE III.—AZIMUTH ERROR of the TRANSIT INSTRUMENT.

[The sign + indicates that the Optic Axis points East of North.]

Day, and Local Mean Solar Time.	Stars.	Azimuth Error.	
		Observed.	Adopted.
1874. h m		″	″
November 15, 14. 36	σ Octantis S.P. and Sirius	−14·18	−14·2
16	....	...	− 8·0
17, 12. 43	Aldebaran and Canopus	− 3·33	
12. 50	α Trianguli S.P. and Canopus	−11·78	−13·95
14. 29	σ Octantis S.P. and Sirius	−13·94	
18, 14. 24	σ Octantis S.P. and Sirius	− 0·73	− 0·7
19, 14. 20	σ Octantis S.P. and Sirius	+ 1·03	+ 1·0
20	....	...	+ 1·0

Table III.—Azimuth Error of the Transit Instrument—*continued.*

Day, and Local Mean Solar Time.	Stars.	Azimuth Error. Observed.	Azimuth Error. Adopted.
1874. h m		″	″
November 22, 14. 8	σ Octantis S.P. and ε Canis Majoris	+ 0·91	+ 0·9
23, 9. 30	α Eridani and β Arietis	+14·80	
12. 26	θ Ceti and α Trianguli S.P.	+14·50	+ 9·0
	67 Ceti and α Trianguli S.P.	+ 9·66	
24, 10. 15	ν Piscium and z Octantis S.P.	+ 7·45	+ 7·4
25, 9. 16	α Eridani and α Arietis	+ 4·25	+ 4·9
	η Piscium and α Eridani	+ 5·62	
26, 9. 34	α Eridani and β Centauri S.P.	+ 9·09	
10. 7	67 Ceti and z Octantis S.P.	+ 3·67	+ 3·4
13. 52	σ Octantis S.P. and Sirius	+ 3·23	
27, 10. 3	z Octantis S.P. and α Ceti	+11·71	+12·1
13. 48	γ^1 Eridani and σ Octantis S.P.	+12·33	
30, 13. 44	Canopus and δ Geminorum	+25·54	+26·4
	Canopus and Procyon	+27·33	
December 3	....	...	+39·5
4, 8. 41	ε Piscium and α Eridani	+39·46	+39·1
	η Piscium and α Eridani	+39·62	
6	....	...	+38·3
7, 23. 31	Antares and α Trianguli	+37·22	+36·7
	ε Orionis and α Trianguli	+36·22	
8, 13. 3	ν Orionis and σ Octantis S.P.	+35·10	
	σ Octantis S.P. and A Octantis	+34·29	+34·3
15. 3	δ Geminorum and A Octantis	+32·19	
10	....	...	+35·2
11, 12. 50	σ Octantis S.P. and Sirius	+37·12	
	σ Octantis S.P. and A Octantis	+36·05	+36·0
	ε Canis Majoris and A Octantis	+33·52	
12, 9. 6	67 Ceti and z Octantis S.P.	+37·65	+37·6
12. 46	δ Orionis and σ Octantis S.P.	+39·88	+39·9
15, 12. 34	σ Octantis S.P. and Canopus	+38·23	+38·2
17, 12. 29	ν Orionis and σ Octantis S.P.	− 4·88	
	σ Octantis S.P. and A Octantis	− 5·25	− 5·2
14. 27	Sirius and A Octantis	− 6·01	
18, 8. 40	z Octantis S.P. and δ Arietis	− 2·13	
	z Octantis S.P. and A Octantis	− 5·01	− 5·0
14. 24	ε Orionis and A Octantis	− 6·75	
20, 8. 36	z Octantis S.P. and τ Arietis	−21·85	−21·7
21. 18	σ Octantis S.P. and ε Canis Majoris	−21·04	
21, 10. 30	....	...	−12·0
22, 14. 8	Pollux and A Octantis	− 3·88	− 3·8

Table III.—Azimuth Error of the Transit Instrument—*continued.*

Day, and Local Mean Solar Time.	Stars.	Azimuth Error. Observed.	Azimuth Error. Adopted.
1874. h m		"	"
December 24, 8. 17	z Octantis S.P. and α Ceti	+ 0·52	+ 0·5
27, 13. 48	Procyon and A Octantis	+16·89	+16·9
28, 11. 44	σ Octantis S.P. and ε Canis Majoris	+18·86	+17·0
	σ Octantis S.P. and A Octantis	+17·02	
13. 44	γ Canis Majoris and A Octantis	+13·07	
31, 11. 32	ε Leporis and σ Octantis S.P.	+ 3·76	+ 3·8
1875.			
January 8, 12. 59	Pollux and A Octantis	−16·76	−16·7
10, 10. 55	α Columbæ and σ Octantis S.P.	− 4·37	− 4·3
13, 9. 5	α Trianguli S.P. and ε Leporis	− 2·92	− 2·5
10. 43	α Columbæ and σ Octantis S.P.	− 2·54	
16, 12. 30	Procyon and A Octantis	+10·26	+12·2
13. 25	A Octantis and B Octantis S.P.	+13·04	
13. 25	ε Hydræ and B Octantis S.P.	+14·12	
17, 10. 27	ε Leporis and σ Octantis S.P.	+10·40	+10·4
21, 12. 9	γ Canis Majoris and A Octantis	− 2·18	− 2·1
23, 10. 3	ε Orionis and σ Octantis S.P.	+ 4·79	+ 4·8
	σ Octantis S.P. and A Octantis	+ 4·06	
12. 0	γ Geminorum and A Octantis	+ 2·58	+ 2·8
12. 51	A Octantis and B Octantis S.P.	+ 2·88	
	Sirius and B Octantis S.P.	+ 2·99	
26, 9. 51	α Orionis and σ Octantis S.P.	+ 4·18	+ 4·2
27, 12. 36	Procyon and B Octantis S.P.	+ 1·82	+ 1·8
29, 9. 40	α Orionis and σ Octantis S.P.	+11·02	+ 9·5
	σ Octantis S.P. and A Octantis	+ 9·49	
11. 38	Castor[2] and A Octantis	+ 6·41	

Table III.—Azimuth Error of the Transit Instrument—*concluded.*

Date, and L. M. T.	Stars.	Azimuth Error. Observed.	Azimuth Error. Adopted.
1875. h m		"	"
February 8, 11. 0	A Octantis and η Cancri	+ 9·21	+ 6·6
11. 49	A Octantis and B Octantis S.P.	+ 5·46	
11. 49	ϵ Hydræ and B Octantis S.P.	+ 3·99	
9, 6. 30	Meridian Mark (uncertain)	+ 12·2	+ 11·2
11, 8. 49	σ Octantis S.P. and Sirius	− 15·74	− 15·8
12, 8. 25	Meridian Mark (uncertain)	− 9·6	− 6·0
8. 46	σ Octantis S.P. and Sirius	− 6·03 *	
13, 8. 42	β Orionis and σ Octantis S.P., Wire 1	− 18·14	− 18·1
	β Orionis and σ Octantis S.P., Wire 2	− 23·34	
	β Orionis and σ Octantis S.P., Wire 3	− 12·50	
	β Orionis and σ Octantis S.P., Wire 4	− 16·71	
14, 11. 26	Procyon and B Octantis S.P.	− 11·48	− 11·5
17, 10. 22	Procyon and A Octantis	− 1·35	− 1·4
18, 10. 16	Pollux and A Octantis	− 6·25	− 6·2
19, 10. 12	6 Cancri and A Octantis	− 16·33	− 15·6
11. 0	A Octantis and B Octantis S.P.	− 15·56	
11. 0	B Octantis S.P. and 83 Cancri	− 15·27	
21, 10. 0	A Octantis and η Cancri	− 19·90	− 18·6
10. 0	A Octantis and C Octantis S.P.	− 18·63	
12. 0	C Octantis S.P. and ρ Leonis	− 15·21	
22, 12. 0	ϵ Canis Majoris and C Octantis S.P.	− 37·10	− 37·1
23	By Meridian Mark	+ 2·5	+ 2·5
25	By Meridian Mark	+ 7·2	+ 7·2
26, 15. 30	η Boötis and β Centauri	+ 0·97	+ 0·5
16. 5	Arcturus and α^2 Centauri	+ 0·11	

* February 12, The recorded time of observation of σ Octantis S.P. has been diminished one minute.

ABSTRACTS of TABLES IV. and V.—TRANSITS of STARS and of the MOON, and Inferred R.A. of the MOON'S LIMB at TRANSIT.

Day, 1874.		Observer.	Reading and Position of Micrometer Head.	Number of Transits of Clock Stars.	Number of Transits of Circumpolar Stars.	Mean Sidereal Time of Transits of Clock Stars.	Clock Slow on Local Sidereal Time.	Clock's Losing Rate.	Limb of Moon observed.	Clock Time of Transit of Moon's Limb over Meridian.	Right Ascension of Moon's Limb at Transit over Meridian.
			rev.			h m	s	s		h m s	h m s
Nov.	15	WS	20·500 W.	3		5. 21	+46·04	+ 2·40			
		BS	20·548 W.	5	1	6. 34	+46·07				
	16	WS	20·548 W.	[illegible]		1. 47	+47·57	+ 2·40			
		BS		4		3. 29	+48·01		I.	21. 23. 58·49	21. 24. 45·43
	17	P	20·555 W.	7	1	4. 46	+50·75	+ 2·43	I.	22. 17. 59·09	22. 18. 48·95
	18	BS	20·555 W.	4		2. 38	+53·00	+ 2·48			
		G		3	1	6. 41	+53·37				
	19	P	20·555 W.	2		23. 5	+54·63	+ 2·50			
		WS		4		4. 12	+55·30				
		P		4		5. 13	+55·40				
		G		3	1	6. 50	+55·90				
	20	G		2		2. 46	(+57·97)	+ 2·47			
	22	WS		4		5. 28	(+63·09)	+ 2·34			
		P	20·555 E.		1						
		P	20·555 W.	5	1	7. 15	+63·28				
	23	G		5		1. 39	+65·04	+ 2·63	II.	3. 58. 23·20	3. 59. 28·16
	24	BS	20·555 W.	4	1	1. 53	+67·97	+ 3·14			
			20·555 E.		1						
	26	G	20·555 W.	10	2	2. 50	+14·97	+ 3·21			
	30	BS	20·555 E.	6		6. 56	+27·65	+ 3·25			
Dec.	3	BS	20·555 E.	5		3. 36	(+36·18)	+ 3·39			
	4	P	20·555 W.	4		1. 18	+39·30	+ 3·23			
	6	WS	20·555 W.	1		13. 18	(+46·65)	+ 3·07			
	7	WS	20·555 W.	3		12. 49	+50·02	+ 3·17			
	8	WS	20·555 W.	3		23. 35	(+51·61)	+ 3·19			
		WS		5	2	6. 42	+52·32				
	10	BS	20·555 E.	3		3. 58	(+58·39)	+ 3·11			
	11	P	20·555 W.	3	2	6. 50	+61·83	+ 3·10			
	12	BS	20·555 W.	7	2	4. 22	+64·63	+ 3·14			
	15	G	20·555 W.	5		2. 37	(+73·92)	+ 3·28			
		WS		4	1	6. 29	+74·43				
	17	BS	20·555 W.	4		3. 29	(+20·68)	+ 3·33			
		WS		8	2	6. 4	+21·07				

Abstracts of Tables IV. and V.—Transits of Stars and of the Moon, &c.—*continued.*

Day, 1874.		Observer.	Reading and Position of Micrometer Head.	Number of Transits of Clock Stars.	Number of Transits of Circumpolar Stars.	Mean Sidereal Time of Transits of Clock Stars.	Clock Slow on Local Sidereal Time.	Clock's Losing Rate.	Limb of Moon observed.	Clock Time of Transit of Moon's Limb over Meridian.	Right Ascension of Moon's Limb at Transit over Meridian.
			rev.			h m	s	s		h m s	h m s
Dec.	18	G	20·527 W.	7	1	3. 29	+23·99	+ 3·26			
		WS		6	1	5. 32	+24·34				
	20	WS	20·527 W.		1						
		G		12	1	5. 12	+30·49	+ 3·26			
	21	P	20·527 W.	5		5. 19	(+32·34)	+ 3·38	I.	4. 28. 22·08	4. 28. 54·14
	22	G	20·537 W.	9	1	7. 14	+37·54	+ 3·19			
	23	P	20·537 W.	3		6. 23	(+40·78)	+ 2·87			
	24	G	20·537 W.	1	1	3. 13	+43·26	+ 2·92			
	27	P	20·537 W.	7	1	6. 53	+53·17	+ 3·53			
		G		1					II.	10. 39. 9·72	10. 40. 3·44
	28	WS	20·537 W.	4	2	6. 54	+56·69	+ 3·43			
	30	WS	20·566 W.	5	1						
	31	WS	20·566 W.	5	1	6. 6	+65·92	+ 3·14			
1875.											
Jan.	8	C	20·566 W.	6	1	7. 20	+32·79	+ 2·72			
	10	CC	20·566 W.	9	1	5. 40	+38·42	+ 3·42			
	13	CC	20·566 W.	7	1	} 5. 39	+48·33	+ 3·38			
		CC	20·566 E.	1	1						
	16	CC	20·564 W.	3	2	8. 31	+59·16	+ 3·72			
	17	C	20·564 W.	7	1	4. 59	+62·40	+ 3·75	I.	4. 0. 52·37	4. 1. 54·84
	21	P	20·564 W.	9	1	6. 22	+16·60	+ 3·50			
	22	WS	20·564 W.						I.		
									II.		No stars.

Abstracts of Tables IV. and V.—Transits of Stars and of the Moon, &c.—*continued.*

Day, 1875.	Observer.	Reading and Position of Micrometer Head.	Number of Transits of Clock Stars.	Number of Transits of Circumpolar Stars.	Mean Sidereal Time of Transits of Clock Stars.	Clock Slow on Local Sidereal Time.	Clock's Losing Rate.	Limb of Moon observed.	Clock Time of Transit of Moon's Limb over Meridian.	Right Ascension of Moon's Limb at Transit over Meridian.
		rev.			h m	s	s		h m s	h m s
Jan. 23	C	20·564 W.	8	1	5. 29	+23·41	+ 3·59			
	C		7	2	11. 27	+24·27		II.	10. 15. 52·29	10. 16. 16·53
26	[illegible]	20·564 W.	9	1	5. 8	+33·95	+ 3·34			
	C		3		12. 32	(+34·95)		II.	12. 35. 7·99	12. 35. 42·96
27	P	20·564 W.	6	1						
	P	20·530 W.	1		10. 1	+38·42	+ 3·60	II.	13. 19. 5·52	13. 19. 44·18
	[illegible]	22·728 W.	1							
29	[illegible]	20·564 W.	9	2	6. 58	+44·80	+ 3·34	II.		No Stars.
Feb. 8	P	20·564 W.	7	1	9. 19	+20·96	+ 3·64			
	WS			1						
9	CC	20·563 W.						I.		No Stars.
	CC	20·564 W.	1							
11	P	20·564 W.	5	1	6. 28	+30·76	+ 3·39			
12	CC	20·564 W.	8	1	7. 8	(+34·24)	+ 3·50	I.	2. 42. 54·90	2. 43. 28·02
13	C	20·564 W.	4		5. 10	(+38·01)	+ 3·73	I.	3. 41. 55·12	3. 42. 33·08
	C	17·504 W.		1						
	C	17·997 W.		1						
	C	18·683 W.		1						
	C	18·863 W.		1						
14	P	20·564 W.	6	1	7. 51	+41·78	+ 3·76			
17	P	20·587 W.	8	1	7. 26	+53·12	+ 3·91	I.	7. 57. 12·69	7. 58. 5·58
18	CC	20·587 W.	12	1	8. 2	+57·15	+ 3·65	I.	8. 56. 2·74	8. 57. 0·11

Abstracts of Tables IV. and V.—Transits of Stars and of the Moon, &c.—*concluded.*

Day, 1875.	Observer.	Reading and Position of Micrometer Head.	Number of Transits of Clock Stars.	Number of Transits of Circumpolar Stars.	Mean Sidereal Time of Transits of Clock Stars.	Clock Slow on Local Sidereal Time.	Clock's Losing Rate.	Limb of Moon observed.	Clock Time of Transit of Moon's Limb over Meridian.	Right Ascension of Moon's Limb at Transit over Meridian.
		rev.			h m	s	s		h m s	h m s
Feb. 19	C	20·587 W.	7	2	9. 10	+60·64	+ 3·53	I.	9. 50. 24·94	9. 51. 25·81
								II.	9. 52. 39·60	9. 53. 40·66
21	CC	20·587 W.	9	2	10. 48	+ 8·56	+ 3·69	II.	11. 30. 58·41	11. 31. 7·14
23	WS	20·587 W.	2		14. 5		+ 3·27	II.	13. 0. 24·92	13. 0. 40·18
26	CC	20·586 W.	7		13. 26	+26·39	+ 3·68	II.	15. 18. 59·22	15. 19. 26·08

TABLE VI.—LONGITUDE of OBSERVATORY BAY, KERGUELEN ISLAND, from the OBSERVED RIGHT ASCENSION of the MOON on the MERIDIAN.

Day.	Observer.	Limb observed.	Observed R.A. of Moon's Limb on the Meridian.	Longitude by the Ephemeris. ϵ = the Correction required to the Moon's Tabular R.A.	Adopted Value of ϵ.	Resulting Longitude, East of Greenwich.	Weight.	Remarks.
1874.			h m s	h m s	s	h m s		
Nov. 16	BS	I.	21. 24. 45·43	4. 39. 33·27 + 26·20 ϵ	−0·31	4. 39. 25·1	7	Daylight. Clock-error determined 5 hours after the lunar observation, and no star observed for azimuth-error. Azimuth unsteady.
17	P	I.	22. 18. 48·95	33·24 + 27·03 ϵ	−0·33	24·3	6	Daylight. Clock and azimuth-errors determined 5 hours after the lunar observation. Azimuth unsteady. Otherwise good observation.
23	G	II.	3. 59. 28·16	50·84 + 21·82 ϵ	−0·71	35·3	21	Good observation; hazy clouds. Clock and azimuth-errors satisfactory.
Dec. 21	P	I.	4. 28. 54·14	46·57 + 21·66 ϵ	−0·66	32·3	21	Clock-error depends on two stars near the Moon. No determination of azimuth-error. Azimuth very unsteady.
27	G	II.	10. 40. 3·44	4. 39. 57·61 + 29·85 ϵ	−0·81	4. 39. 33·4	11	Clock-error depends on a single star near the Moon. Azimuth satisfactory and otherwise good observation; daylight.

Table VI.—Longitude of Observatory Bay, from the observed R.A. of the Moon on the Meridian—*concluded.*

Day.		Observer.	Limb observed.	Observed R.A. of Moon's Limb on the Meridian.	Longitude by the Ephemeris. ϵ = the Correction required to the Moon's Tabular R.A.	Adopted Value of ϵ.	Resulting Longitude, East of Greenwich.	Weight.	Remarks.
1875.				h m s	h m s	s	h m s		
Jan.	17	C	I.	4. 1. 54·84	4. 39. 44·89 + 22·90 ϵ	−0·55	4. 39. 32·3	19	Good observation, through haze; clock and azimuth-errors satisfactory.
	22	WS	I. & II.	....	....	..	....	..	No stars observed.
	23	C	II.	10. 16. 16·53	42·45 + 28·30 ϵ	−0·58	26·0	15	Good observation; clock and azimuth-errors satisfactory.
	26	C	II.	12. 35. 42·96	49·18 + 32·79 ϵ	−0·47	33·8	9	Good observation; clock and azimuth-errors satisfactory.
	27	P	II.	13. 19. 44·18	39·13 + 32·61 ϵ	−0·44	24·8	6	Moon observed on four wires, at two of which the limb was scarcely visible. Clock and azimuth-errors satisfactory.
	29	CC	II.	....	....	..	....	..	Moon observed on one wire only, and no stars with it.
Feb.	9	CC	I.	....	....	..	....	..	No stars observed with the Moon.
	12	CC	I.	2. 43. 28·02	45·75 + 25·00 ϵ	−0·46	33·2	11	Clock and azimuth-errors determined 3 hours after the lunar observation. Azimuth very unsteady. Good observation otherwise.
	13	C	I.	3. 42. 33·08	49·84 + 23·62 ϵ	−0·52	37·6	18	Clock-error applied depends upon a single star near the Moon. Azimuth-error satisfactory and good observation.
	17	P	I.	7. 58. 5·58	4. 39. 50·55 + 23·62 ϵ	−0·61	36·1	18	Much tremor. Clock and azimuth-errors satisfactory.
	18	CC	I.	8. 57. 0·11	4. 40. 10·17 + 25·42 ϵ	−0·60	54·9	16	Fair observation. Clock and azimuth-errors satisfactory.
	19	C	I.	9. 51. 25·81	4. 40. 5·78 + 27·52 ϵ	−0·58	49·8	7	Limb very unsteady. Clock inaudible from high wind; B S marking seconds. Otherwise clock and azimuth-errors satisfactory. Moon's II. defective.
	,,	,,	II.	9. 53. 40·66	4. 39. 53·94 + 27·52 ϵ	−0·58	38·0	7	
	21	CC	II.	11. 31. 7·14	38·75 + 31·25 ϵ	−0·53	18·2	10	Good observation. Clock and azimuth-errors satisfactory.
	23	WS	II.	13. 0. 40·18	43·13 + 32·43 ϵ	−0·45	28·5	5	Moon observed at two wires only; clock correction depends upon two stars which are discordant. No determination of azimuth-error.
	26	CC	II.	15. 19. 26·08	4. 39. 37·39 + 28·98 ϵ	−0·35	4. 39. 27·2	12	Good observation; clock and azimuth-errors satisfactory.

TABLE VII.—ABSTRACT of LONGITUDES of OBSERVATORY BAY, from the OBSERVED AZIMUTHS of the MOON'S FIRST LIMB.

CLASS A.—STARS OBSERVED WITH THE MOON.

1874–75.		Number of Observations = n.	Mean Inferred Longitude from each Day's Observations.	Mean Difference of Tabular Azimuth = a.	Weight $a^2\sqrt{n}$.	Remarks.
Observer, W S. Moon's I. L.						
			h m s	"		
November	15	3	4. 39. 28·6	31	17	Cloudy at times.
	16	5	43·0	33	24	☽ limb very unsteady. Cloudy.
	17	2	34·9	34	16	☽ limb much serrated. Cloudy.
	18	4	25·7	41	34	Fair observations.
	19	2	33·9	42	25	☽ limb well defined.
	22	4	40·4	38	29	Cloudy, but fair observations.
	23	2	41·5	29	12	Good observations.
December	15	2	26·8	40	23	Snowstorms. ☽ limb well defined.
	17	2	30·5	40	23	Fair observations.
	18	6	29·7	40	39	☽ limb well defined.
	20	3	40·5	37	24	☽ limb bright and clear.
January	10	3	34·9	33	19	Daylight; ☽ limb bright and well defined.
	13	4	31·6	37	27	Clear.
	21	2	40·6	35	17	High wind: Lieut. Coke calling seconds. *Defective limb.*
February	11	3	40·8	36	22	High wind: Mr. Smith calling seconds.
	12	4	42·0	36	26	High wind: clock often inaudible.
	14	2	35·1	35	17	Observed in a momentary interval between clouds.
	18	2	4. 39. 55·8	35	9	Driving haze. ☽ limb very ill defined. Clock often inaudible.
Mean with weights, 4h. 39m. 35s·26.						
Observer, G. Moon's I. L.						
			h m s	"		
December	17	2	4. 39. 29·8	40	23	☽ limb very unsteady.
	18	6	4. 39. 34·2	40	39	High wind.
Mean with weights, 4h. 39m. 32s·56.						

Table VII.—*continued.*

1874–75.		Number of Observations = n.	Mean Inferred Longitude from each Day's Observations.	Mean Difference of Tabular Azimuth = a.	Weight $a^2\sqrt{n}$.	Remarks.
Observer, B S. Moon's I. L.						
			h m s	″		
February	19	2	4. 39. 38·3	35	17	☽ limb much serrated. Clock often inaudible.
CLASS B.—NO STARS OBSERVED WITH THE MOON.						
Observer, P. Moon's I. L.						
			h m s	″		
November	19	4	4. 39. 27·2	38	29	
	20	2	14·1	42	25	Cloudy.
	21	4	30·5	41	34	High wind. Clock often inaudible.
January	13	4	4. 39. 33·0	36	26	Clear.
Mean with weights, $4^h. 39^m. 26^s·6$.						
Observer, C C. Moon's I. L.						
			h m s	″		
January	17	2	4. 39. 33·3	36	18	
February	11	2	4. 39. 42·0	36	18	
Mean with weights, $4^h. 39^m. 37^s·7$.						
Observer, W S. Moon's I. L.						
			h m s	″		
November	27	4	4. 39. 26·4	42	35	Haze, but ☽ limb well defined.
Observer, B S. Moon's I. L.						
			h m s	″		
February	18	2	4. 39 46·3	34	16	☽ limb serrated. Clock almost inaudible.

TABLE VII. (*continued*).—ABSTRACT of LONGITUDES of OBSERVATORY BAY, from the observed AZIMUTHS of the MOON'S SECOND LIMB.

CLASS A.—STARS OBSERVED WITH THE MOON.

1874–75.		Number of Observations = n.	Mean Inferred Longitude from each Day's Observations.	Mean Difference of Tabular Azimuth = a.	Weight $a^2\sqrt{n}$.	Remarks.
Observer, W S. Moon's II. L.						
			h m s	″		
November	23	2	4. 39. 48·2	39	21	Haze.
	24	2	34·8	36	18	Clear. ☽ limb good.
	26	2	27·9	34	16	☽ limb well defined, but faint.
January	21	2	28·2	35	17	High wind: Lieut. Coke calling seconds.
	23	4	29·6	35	24	Fair observations.
	23	2	28·5	25	9	☽ limb not good.
	27	2	30·7	31	14	Haze; ☽ limb unsteady and woolly.
	29	2	38·0	28	11	☽ limb serrated and unsteady.
February	21	4	29·9	33	22	Good observations.
	21	2	4. 39. 22·7	25	9	Good observations.
Mean with weights, $4^h. 39^m. 32^s{\cdot}54$.						

CLASS B.—NO STAR OBSERVED WITH THE MOON.

1874–75.		Number of Observations = n.	Mean Inferred Longitude from each Day's Observations.	Mean Difference of Tabular Azimuth = a.	Weight $a^2\sqrt{n}$.	Remarks.
Observer, P. Moon's II. L.						
			h m s	″		
January	23	3	4. 39. 12·3	35	21	High wind; clock inaudible.
	27	2	4. 39. 19·1	35	17	High wind; clock almost inaudible.
Mean with weights, $4^h. 39^m. 15^s{\cdot}3$.						
Observer, C C. Moon's II. L.						
			h m s	″		
January	26	2	4. 39. 29·8	38	20	High wind; clock almost inaudible.

Table VII.—*concluded.*

1874–75.		Number of Observations = n.	Mean Inferred Longitude from each Day's Observations.	Mean Difference of Tabular Azimuth = a.	Weight $a^2\sqrt{n}$.	Remarks.
Observer, W S. Moon's II. L.						
			h m s	"		
November	30	4	4. 39. 44·9	31	19	High wind; clock inaudible.
December	24	2	41·6	35	17	Through thick haze.
	27	5	38·1	33	24	Haze. ☽ limb sometimes good.
	28	2	28·1	32	14	High wind; clock often inaudible.
	31	7	33·4	33	29	Cloud. ☽ limb well defined sometimes.
January	26	2	4. 39. 33·3	32	14	High wind. Mr. Smith calling seconds.
Mean with weights, $4^{h}. 39^{m}. 36^{s}·8$.						
Observer, B S. Moon's II. L.						
			h m s	"		
January	27	2	4. 39. 29·6	33	15	High wind.

TRANSIT OF VENUS, 1874.

PART IV.

EXPEDITION TO KERGUELEN ISLAND

(*continued*).

Section 2.

OBSERVATIONS AT SUPPLY BAY, ROYAL SOUND,

By Lieutenant CYRIL CORBET, R.N.,

AND

Lieutenant G. ELMSLEY COKE, R.N.

With One Plate.

CONTENTS.

Establishment at Supply Bay.

It was at first thought to be possible to establish a station on Heard Island which should depend, as regards longitude and base of operations, upon the head station on Kerguelen Island. Lieutenants Cyril Corbet and G. Elmsley Coke, R.N., accompanied the expedition under the Reverend S. J. Perry with this object in view, and also to conduct the chronometric connections.

After the arrival of the Expedition in Kerguelen Island, it was found that the idea of occupying Heard Island must be abandoned. Not only were the reports of the masters of the sealing vessels very unfavourable, but it was doubtful whether the amount of fuel carried by the ships would be sufficient for the trips to be made for the longitude connection.

Mr. Corbet, therefore, assisted by Staff Commander Inglis, R.N., commanding H.M.S. *Supply*, explored the S.W. portion of Royal Sound; and having fixed upon a sheltered inlet (near to the isthmus called "Swain's Haulover"), which he named "Supply Bay," for the position of his station (*see* the map, Plate XVI.), he proceeded to establish an independent observatory there.

They arrived on their ground in the *Supply*, 1874, November 5; and, with assistance from the ships, the little station (consisting of a dwelling-house, observatory, and storehouse) was built and equipped by November 11, when the *Supply* returned to the better anchorage, leaving at the new station Sub-Lieut. Baynes, a servant, and a cook.

To establish a record of the locality, Lieut. Corbet subsequently took the following bearings from the Transit Instrument :—

Cross bearings, corrected to the Astronomical Meridian, taken from the Transit Instrument.

	° ′
Extreme of Island in the center of Harbour, at high water	S. 89. 30. E.
Do. do. do.	S. 77. 0. E.
Point at Southern entrance to Harbour	S. 72. 40. E.
Extreme of a bold lump on the top of the Hill to the Southward. The lump being about the highest spot to the Southward, of bold rock, with a little lichen over it	S. 6. 30. E.
Extreme of the highest bold cliff on the top of the hills to the West and N. West	N. 46. 0. W.
Mount Wyville Thompson	S. 79. 40. E.

[The attached symbols in the MS. appear to denote that No. 1 was at the left hand, and Nos. 2, 4, 5 at the right hand.—G. B. A.]

Lieut. Corbet was provided with the following instruments :—

A portable transit instrument.

A portable altazimuth.

An astronomical clock.

12 chronometers.

A 4-inch achromatic telescope, on tripod stand, by Simms.

A $3\frac{1}{4}$-inch achromatic telescope, on tripod stand, by Dollond (lent from the Cambridge Observatory).

Mercurial and aneroid barometers, thermometers, prismatic compass, &c.

Observations for local time, with both the transit instrument and the altazimuth, were as continuous as the bad weather permitted, from December 4 to December 21 ; and the latitude was sufficiently well determined.

On December 17 Mr. Corbet left the station in charge of Mr. Coke, and commenced the work of connecting the various stations with the chronometers. On December 21 he returned and dismantled the station.

The clock by Baker was lent by the Council of the Royal Astronomical Society. The pendulum was compensated on the gridiron principle. The movements were put into good repair before leaving England.

The following is a list of the chronometers :—

A. Arnold 536.
B. McCabe 360.
C. Loseby 113.
D. Poole 3164.
E. Dent 1981.
F. Hewitt 991.
G. Frodsham and Baker 6149.
H. Frodsham and Baker 6188.
l. Dent 1916.
m. Muston 611.
n. Molyneux 1061.
S. Kullberg 2177.
Z. C. Frodsham 5004.

The portable transit, kindly lent by H. Kains Jackson, Esq., of Orpington, is by Troughton and Simms, of three inches aperture. It was supported on an iron stand, which was intended to rest upon a pier of masonry.

At Supply Bay a pier of brick and cement was built, on a foundation of concrete, on hard ground; but Lieut. Corbet placed between the masonry and the iron stand a block of wood, to which the iron stand was screwed; apparently to facilitate fastening down the latter.

On November 20 a furious gale blew off the roof of the observatory, and the transit was knocked out of its Y's, and fell to the floor on its eye-end and setting circle, which was much bent. This being straightened with the hands, the instrument was found to be apparently but little the worse for the accident.

The correction for inequality of pivots was carefully determined. It was found to be $0''\cdot11$ (+ lamp E., − lamp W.), which has been applied to all the level errors given in the following tables.

The error of collimation is determined by observations of stars with reversed positions of the transit axis. It appears that Lieut. Corbet was in the habit of testing the stability of the collimation and azimuth errors, by directing the telescope to and reversing it on a distant terrestrial object; but the instrument having no micrometer, he could not of course make accurate observations in this manner. He appears to have had no suspicion that anything was wrong with the instrument, but was puzzled at the apparent instability of the azimuthal position.

I have no doubt that in this case, as with all the other transits made by Troughton and Simms, the ring clamp at the eye end of the telescope, which fixed the wire plate, had worked loose during the voyage, and consequently the system of wires was not rigidly fixed with reference to the optical axis. It is of course possible that the object-glass was loosely attached, but it is improbable, from the mode of attachment. No record is to be found of any special examination of the instrument.

With the instrument in this condition, with the additional fault of being mounted on a block of wood, in a climate where heavy rains and fierce winds perpetually alternated, good observations for local time were impossible.

The value of the divisions of the hanging spirit-level was determined by the makers before leaving England, and again on the return of the expedition to Greenwich; 40 divisions were found equal to one minute of arc. The level error was generally large, but the determination of local time is not injuriously affected on this account.

It follows from the description of the instrument and its mounting that the azimuth error can never be inferred with any certainty. It has been computed in every possible way from the observations.

TRANSITS of STARS observed at SUPPLY BAY, KERGUELEN ISLAND.

Day.	Observer.	Position of Lamp.	Star's Name.	Number of Wires.	Mean observed Transit over Center Wire.	True Transit over Meridian.	Seconds of Star's Apparent R.A.	Clock apparently Slow.
					h m s	s	s	s
1874. Dec. 4	C C	E	z Octantis S.P.	1	2. 27. 51·0	106·7	30·5	− 16·2
			α Ceti	5	2. 55. 58·6	61·1	45·2	− 15·9
			δ Arietis..........	5	3. 4. 42·2	45·3	29·4	− 15·9
			γ^1 Eridani	5	3. 52. 26·8	28·7	12·6	− 16·1
			o^1 Eridani	5	4. 6. 0·1	2·3	46·5	− 15·8
			α Triang. Aust. S.P.	2	4. 35. 23·9	32·4	21·2	− 11·2
		W	β Orionis	2	5. 8. 43·8	46·5	32·6	− 13·9

Error of Level.

Sidereal Time.	Lamp.	Level Error.
h m		″
2. 40	E.	+ 6·64
3. 25	E.	+ 6·27
4. 20	E.	+ 5·33
5. 18	W.	+ 2·36

Error of Azimuth.

	″
By z Octantis S.P., Lamp E., and α Ceti E. ...	+ 31
o^1 Eridani E., and α Triang. Aust. S.P. E...	+ 63
Time Stars, Lamp E.	+ 59

Adopted, + 50″·0

Day.	Observer.	Position of Lamp.	Star's Name.	Number of Wires.	Mean observed Transit over Center Wire.	True Transit over Meridian.	Seconds of Star's Apparent R.A.	Clock apparently Slow.
					h m s	m s	s	s
1874. Dec. 8	C C	W	z Octantis S.P.	5	2. 29. 38·2	28. 18·9	32·5	+ 13·6
			γ^1 Eridani	3	3. 52. 36·3	36·8	12·6	− 24·1
			α Tauri	4	4. 29. 10·8	9·9	45·5	− 24·4
			α Triang. Aust. S.P.	2	4. 35. 53·4	45·9	21·3	− 24·5
		E	α Triang. Aust. S.P.	2	4. 35. 52·1	46·3	21·3	− 25·0
			ϵ Leporis	5	5. 0. 35·7	35·9	11·2	− 24·7
			β Orionis	5	5. 8. 57·5	57·1	32·6	− 24·5
			β Tauri	5	5. 18. 50·9	48·8	24·1	− 24·6
			δ Orionis	5	5. 26. 3·4	2·6	37·9	− 24·7
			α Leporis.........	1	5. 27. 38·5	38·5	13·9	− 24·6
			ϵ Orionis	5	5. 30. 18·2	17·4	52·9	− 24·5

Error of Level.

Sidereal Time.	Lamp.	Level Error.
h m		″
3. 41	W.	+ 22·24
4. 11	W.	+ 22·05
4. 50	E.	+ 22·39
5. 14	E.	+ 22·95

Error of Azimuth.

	″
By γ^1 Eridani, Lamp W., and z Octantis S.P. W.	+ 7
α Triang. Aust. S.P. W., and γ^1 Eridani W.	− 28
α Triang. Aust. S.P. E., and ϵ Leporis E...	− 29
Time Stars, Lamp W.	− 39
Time Stars, Lamp E.	− 26

Adopted, − 28″·5

Day.	Observer.	Position of Lamp.	Star's Name.	Number of Wires.	Mean observed Transit over Center Wire.	True Transit over Meridian.	Seconds of Star's Apparent R.A.	Clock apparently Slow.
1874.					h m s	s	s	s
Dec. 12	C C	E	z Octantis S.P.	3	2. 28. 30·9	54·9	34·2	− 20·7
			γ^2 Ceti	5	2. 37. 16·9	19·4	49·8	− 29·6
			α Ceti	5	2. 56. 12·3	14·8	45·2	− 29·6
			δ Arietis	5	3. 4. 56·6	59·1	29·4	− 29·7
			η Tauri..........	5	3. 40. 31·0	33·5	3·9	− 29·6
		W	γ^1 Eridani	5	3. 52. 38·5	42·6	12·6	− 30·0
			o^1 Eridani........	5	4. 6. 12·5	16·7	46·6	− 30·1
			ε Tauri	5	4. 21. 45·5	49·7	19·7	− 30·0
			α Tauri..........	5	4. 29. 11·4	15·6	45·6	− 30·0
			α Triang. Aust. S.P.	2	4. 35. 49·0	50·2	21·5	− 28·7
		E	α Triang. Aust. S.P.	2	4. 35. 47·5	52·9	21·5	− 31·4

Error of Level.

Sidereal Time.	Lamp.	Level Error.
h m		"
2. 33	E.	+ 28·95
2. 47	E.	+ 30·08
3. 23	E.	+ 30·27
4. 0	W.	+ 32·92
4. 47	E.	+ 33·27

Error of Azimuth.

By z Octantis S.P., Lamp E., and γ^2 Ceti E....	+ 47"
γ^2 Ceti E. and α Triang. Aust. S.P. E.	+ 38
α Ceti E. and α Triang. Aust. S.P. E.	+ 38
γ^1 Eridani W. and α Triang. Aust. S.P. W..	+ 62
Time Stars, Lamp E.	+ 35
Time Stars, Lamp W..................	+ 40

Adopted, + 38"·0

Day.	Observer.	Position of Lamp.	Star's Name.	Number of Wires.	Mean observed Transit over Center Wire.	True Transit over Meridian.	Seconds of Star's Apparent R.A.	Clock apparently Slow.
1874.					h m s	m s	s	s
Dec. 17	G E C	E	α Ceti	5	2. 56. 30·4	33·9	45·2	− 48·7
			δ Arietis..........	5	3. 5. 13·8	18·3	29·4	− 48·9
		W	η Tauri	5	3. 40. 46·3	52·9	63·9	− 49·0
			γ^1 Eridani	5	3. 52. 57·2	61·5	12·6	− 48·9
			o^1 Eridani.........	5	4. 6. 30·7	35·3	46·6	− 48·8
			ε Tauri..........	4	4. 22. 2·9	9·1	19·8	− 49·3
			α Tauri..........	5	4. 29. 28·9	34·9	45·6	− 49·3
		E	α Triang. Aust. S.P.	5	4. 35. 57·1	71·5	21·7	− 49·8
			ε Leporis	4	5. 0. 58·7	61·2	11·2	− 50·0
			β Orionis	5	5. 9. 19·0	22·2	32·7	− 49·5
			σ Octantis S.P. ...	2	6. 9. 49·7	14. 47·6	24·0	− 83·6

Error of Level.

Sidereal Time.	Lamp.	Level Error.
h m		"
2. 45	E.	+ 0·27
3. 23	E.	+ 3·27
4. 49	E.	+ 10·39
6. 26	E.	+ 11·14

Error of Azimuth.

By α Trianguli Aust. S.P., Lamp E., and ε Leporis E.	+ 81"
β Orionis E. and σ Octantis S.P. E.......	+ 70
Time Stars, Lamp E.	+ 101
Time Stars, Lamp W.	+ 63

Adopted, + 80"·0

Day.	Observer.	Position of Lamp.	Star's Name.	Number of Wires.	Mean observed Transit over Center Wire.	True Transit over Meridian.	Seconds of Star's Apparent R.A.	Clock apparently Slow.
					h m s	m s	s	s
1874. Dec. 18	G E C	E	z Octantis S.P.	2	2. 28. 51·1	81·6	37·1	− 44·5
		W	α Ceti	5	2. 56. 32·0	35·9	45·2	− 50·7
			η Tauri...	4	3. 40. 50·3	54·5	3·9	− 50·6
		E	ε Tauri	5	4. 22. 8·5	10·8	19·7	− 51·1
			ε Leporis	2	5. 1. 0·6	2·6	11·2	− 51·4
			β Orionis	5	5. 9. 21·7	23·9	32·7	− 51·2
		W	β Tauri	3	5. 19. 11·9	16·0	24·3	− 51·7
			δ Orionis	1	5. 26. 25·5	29·3	38·1	− 51·2
			α Orionis	5	5. 49. 12·5	16·4	25·1	− 51·3
			σ Octantis S.P.....	3	6. 15. 13·6	14. 43·9	24·3	− 79·6
		E	γ Geminorum	3	6. 31. 19·5	21·8	30·2	− 51·6
			α Canis Majoris ...	5	6. 40. 28·9	30·9	39·2	− 51·7

Error of Level.

Sidereal Time.	Lamp.	Level Error.
h m		″
2. 44	E.	+ 22·02
4. 0	W.	+ 24·86
4. 41	E.	+ 26·89
6. 26	W.	+ 25·99
6. 51	E.	+ 26·52

Error of Azimuth.

	″
By z Octantis S.P., Lamp E., and α Ceti W....	+ 44
α Orionis W. and σ Octantis S.P. W.......	+ 31
Time Stars, Lamp W.	+ 28
Time Stars, Lamp E.	+ 47

Adopted, + 38″·0

Day.	Observer.	Position of Lamp.	Star's Name.	Number of Wires.	Mean observed Transit over Center Wire.	True Transit over Meridian.	Seconds of Star's Apparent R.A.	Clock apparently Slow.
					h m s	m s	s	s
1874. Dec. 20	G E C	W	η Tauri...........	5	3. 40. 57·0	62·7	3·9	− 58·8
			γ^1 Eridani	5	3. 53. 9·7	11·9	12·6	− 59·3
			o^1 Eridani.........	5	4. 6. 42·6	45·4	46·6	− 58·8
			ε Tauri	5	4. 22. 13·6	18·7	19·7	− 59·0
		E	ε Leporis	2	5. 1. 10·5	10·8	11·3	− 59·5
			β Orionis	5	5. 9. 30·0	31·5	32·7	− 58·8
			β Tauri	5	5. 19. 18·7	23·3	24·3	− 59·0
			δ Orionis	5	5. 26. 35·3	37·5	38·1	− 59·4
			ε Orionis	2	5. 30. 50·0	52·2	53·1	− 59·1
			α Orionis	5	5. 49. 21·6	24·4	25·1	− 59·3
			σ Octantis S.P.....	3	6. 7. 18·8	14. 23·6	25·0	− 58·6

Error of Level.

Sidereal Time.	Lamp.	Level Error.
h m		″
3. 47	W.	− 29·52
4. 42	E.	− 23·74
6. 24	E.	− 21·11

Error of Azimuth.

	″
By σ Octantis S.P., Lamp E., and β Orionis E..	+ 79
Time Stars, Lamp W.	+ 65
Time Stars, Lamp E.	+ 91

Adopted, + 78″·5

Day.	Observer.	Position of Lamp.	Star's Name.	Number of Wires.	Mean observed Transit over Center Wire.	True Transit over Meridian.	Seconds of Star's Apparent R.A.	Clock apparently Slow.
1874.					h m s	s	s	s
Dec. 21	G E C	E	β Orionis	5	5. 9. 33·4	35·0	32·7	— 62·3
			δ Orionis	3	5. 26. 38·5	40·2	38·1	— 62·1
			ε Orionis	3	5. 30. 53·6	55·3	53·0	— 62·3
		W	α Orionis	3	5. 49. 24·2	27·5	25·1	— 62·4
			σ Octantis S.P......	3	6. 13. 25·7	10·5	25·4	— 14·9
			ε Canis Majoris	5	6. 54. 42·8	45·9	43·8	— 62·1
			γ Canis Majoris....	5	6. 59. 6·3	9·4	7·1	— 62·3
			δ Geminorum......	5	7. 13. 39·4	42·7	40·3	— 62·4
			α^2 Geminorum	5	7. 27. 37·3	41·0	38·3	— 62·7
		E	α Canis Minoris ...	5	7. 33. 47·1	48·9	46·2	— 62·7
			β Geminorum	5	7. 38. 41·3	43·2	40·8	— 62·4
			6 Cancri..........	5	7. 56. 52·3	54·1	51·2	— 62·9

Error of Level.

Sidereal Time.	Lamp.	Level Error.
h m		″
5. 58	W.	+ 17·74
7. 8	W.	+ 16·99
7. 48	E.	+ 18·64

Error of Azimuth.

By σ Octantis S.P., Lamp W., and ε Can. Maj. W. + 55″
Time Stars, Lamp W. .... + 23
Time Stars, Lamp E. .... + 21

Adopted, + 33″·0

ERRORS and RATES of the TRANSIT CLOCK.

Date.	Lamp E. or W.	Sidereal Time.	Clock Slow.	Clock's Apparent Losing Rate.	Adopted Losing Rate.
1874.		h m	s	s	s
December 4	E.	3. 29	— 15·95		
	W.	5. 9	— 13·93		
		4. 19	— 14·94		
8	W.	4. 10	— 24·27	— 2·37	
	E.	5. 18	— 24·59		
		4. 44	— 24·43		— 1·86
12	E.	3. 4	— 29·62	— 1·35	
	W.	4. 12	— 30·01		
		3. 38	— 29·82		— 2·61
17	E.	4. 2	— 49·28	— 3·87	
	W.	4. 5	— 49·04		
		4. 4	— 49·16		— 2·45

Date.	Lamp E. or W.	Sidereal Time.	Clock Slow.	Clock's Apparent Losing Rate.	Adopted Losing Rate.
1874.		h m	s	s	s
Dec. 18	W.	4. 37	− 51·08	− 2·17	
	E.	5. 32	− 51·39		
		5. 5	− 51·24		− 2·75
20	W.	4. 0	− 58·98	− 3·91	
	E.	5. 22	− 59·18		
		4. 41	− 59·08		− 3·71
21	E.	6. 32	− 62·45	− 3·61	
		6. 52	− 62·36		
		6. 42	− 62·41		

The portable altazimuth, also by Troughton and Simms, was lent by Mr. Warren De la Rue. The vertical circle was 12 inches in diameter, and was read by two micrometer-microscopes to single seconds of arc. These microscopes were supported at the extremity of a horizontal bar forming a portion of the solid casting of the revolving body. There was one sensitive zenith distance level, graduated with 40 divisions to the minute. There appears to have been one vertical and one horizontal wire.

This altazimuth was mounted close to the transit-instrument and under the same roof, and with it the following results were obtained for colatitude :—

Day.	Star.	Approx. Z. D.	Apparent Co-latitude.	Day.	Star.	Approx. Z. D.	Apparent Co-latitude.
1874.		° ′	° ′ ″	1874.		° ′	° ′ ″
Nov. 16	β Orionis....	41. 10 N.	40. 29. 6·5	Nov. 26	o^1 Eridani ...	42. 21 N.	40. 29. 2·6
18	γ^1 Eridani ...	35. 39 N.	40. 28. 51·2	27	α Ceti	53. 7 N.	40. 29. 3·2
23	θ Ceti.......	40. 41 N.	40. 29. 7·8		o^1 Eridani ...	42. 21 N.	40. 28. 59·1
	γ Piscium ...	54. 22 N.	40. 29. 6·9		α Triang. Aust.	61. 41 S.	40. 28. 50·4
	67 Ceti	42. 31 N.	40. 29. 11·7	Dec. 2	γ^1 Eridani ...	35. 39 N.	40. 29. 3·7
	ξ^2 Ceti	57. 25 N.	40. 29. 7·4		o^1 Eridani ...	42. 21 N.	40. 28. 57·4
	α Ceti	53. 7 N.	40. 29. 4·4	3	67 Ceti	42. 31 N.	40. 29. 7·2
	γ^1 Eridani ...	35. 39 N.	40. 28. 56·5		ξ^2 Ceti	57. 24 N.	40. 29. 11·1
24	67 Ceti	42. 31 N.	40. 29. 2·1		γ^2 Ceti	52. 14 N.	40. 29. 3·3
	ξ^2 Ceti	57. 25 N.	40. 28. 55·8		α Ceti	53. 7 N.	40. 29. 13·4
	γ^2 Ceti......	52. 13 N.	40. 28. 59·0		γ^1 Eridani ...	35. 39 N.	40. 29. 8·2
	α Ceti	53. 7 N.	40. 28. 51·2	4	α Ceti	53. 7 N.	40. 29. 6·2
26	67 Ceti	42. 31 N.	40. 29. 7·8		γ^1 Eridani ...	35. 39 N.	40. 29. 3·0
	ξ^2 Ceti	57. 25 N.	40. 29. 14·7		o^1 Eridani ...	42. 21 N.	40. 29. 4·0
	γ^2 Ceti......	52. 13 N.	40. 29. 2·0				
	α Ceti	53. 7 N.	40. 29. 15·1		Mean		40. 29. 2·4

All the stars, except α Trianguli Australis, are on the North side of the Zenith. It seems not improbable that the inferred colatitude is a second or two too great.

The results are not so accordant as might have been expected with such an instrument; possibly the discordances are due to the employment of two microscopes only.

On the Longitude of Supply Bay.

As previously arranged, on the evening of November 16 Lieut. Goodridge ascended to the summit of Mussel Island, off the entrance of Observatory Bay, and exploded a quantity of gunpowder at intervals of ten minutes, a preparatory rocket being sent up at 8.30 p.m. The understanding was that similar signals should be made by the American observers five minutes after each of Lieut. Goodridge's signals. The signals from Mussel Island, four in number, were all seen at Observatory Bay, and from a repeating station at Supply Bay; the first three only at Molloy Point. The Molloy Point signals were not seen at Observatory Bay, but were all seen at Supply Bay. The powder flashes being invisible from Supply Bay observatory, Messrs. Coke and Baynes ascended a hill about half a mile distant, whence all the signals were visible. Having their fowling pieces on full cock, they discharged them immediately they perceived the signals, and estimated at once, independently, the loss of time incurred by this repetition. Lieut. Corbet registered the instant of hearing the gunshots. The distance of the repeating station was afterwards measured, and Messrs. Coke and Baynes made a number of experiments to determine the value of their estimates of the loss of time in repeating.

The following are the times recorded and inferred difference of longitude between Supply Bay and Observatory Bay, and between Supply Bay and Molloy Point. Professor S. Newcomb kindly supplies the local mean times observed at Molloy Point.

RECORDED TIMES of GUNPOWDER FLASHES in ROYAL SOUND, and inferred LONGITUDE of SUPPLY BAY.

Signals.	Station.	Observer.	Clock used.	Recorded Clock Time.	Clock Correction.	Local Sidereal Time.	Local Mean Solar Time.	Inferred Supply Bay West of Observatory Bay.	Inferred Supply Bay West of Molloy Point.
				h m s	m s	h m s	h m s	m s	m s
MUSSEL ISLAND SIGNALS.	OBSERVATORY BAY.	W S	Transit-Clock.	0. 46. 42·25	+0. 47·93	0. 47. 30·18	9. 5. 13·2		
				0. 56. 40·8	+0. 47·95	0. 57. 28·75	9. 15. 10·1		
				1. 6. 42·8	+0. 47·97	1. 7. 30·77	9. 25. 10·5		
				1. 16. 41·5	+0. 47·98	1. 17. 29·48	9. 35. 7·6		
		B S	Altaz. Clock.	0. 45. 13·8	+2. 16·37	0. 47. 30·17	9. 5. 13·2		
				0. 55. 13·0	+2. 16·43	0. 57. 29·43	9. 15. 10·8		
				1. 5. 14·8	+2. 16·49	1. 7. 31·29	9. 25. 11·0		
				1. 15. 13·0	+2. 16·56	1. 17. 29·56	9. 35. 7·6		
	SUPPLY BAY.	C C	Clock *Baker*.	0. 44. 38·0* −3·0	+2. 27·02	0. 47. 2·02	9. 4. 45·0	0. 28·20	1. 15·2
				0. 54. 39·0 −3·0	+2 27·09	0. 57. 3·09	9. 14. 44·4	0. 26·05	1. 13·1
				1. 4. 39·5 −3·3	+2. 27·16	1. 7. 3·36	9. 24. 43·1	0. 27·65	1. 15·1
				1. 14. 40·0? −3·1	+2. 27·22	1. 17. 4·12	9. 34. 42·2?	0. 25·40	. .
	MOLLOY POINT.			(Communicated by Professor Simon Newcomb.)			9. 6. 0·2 9. 15. 57·5 9. 25. 58·2 (4th lost.)		
MOLLOY POINT SIGNALS.	MOLLOY POINT.			(Communicated by Professor Simon Newcomb.)			9. 12. 23·2 9. 19. 8·2 9. 34. 12·7		
	SUPPLY BAY.	C C	Clock *Baker*.	0. 51. 4·0 −3·7	+2. 27·07	0. 53. 27·37	9. 11. 9·3	. .	1. 13·9
				0. 57. 50·0 −3·0	+2. 27·10	1. 0. 14·10	9. 17. 54·9	. .	1. 13·3
				1. 12. 55·5 −3·3	+2. 27·20	1. 15. 19·40	9. 32. 57·8	. .	1. 14·9

* The corrections applied to the times by Clock *Baker* at Supply Bay are the estimated loss of time in repeating the signal + 2s·5, the time required by sound to travel from the repeating station to the Observatory.

For the longitude of Supply Bay we have therefore—

	s
1874, November 16, by powder flashes, Supply Bay West of Observatory Bay	26·82
December 17, by chronometers (*see* page 471).......	26·16
December 21 „ („).......	26·22
Adopted Supply Bay West of Observatory Bay......	26·5
	h m s
Observatory Bay East of Greenwich.............	4. 39. 33·5
Supply Bay East of Greenwich	4. 39. 7·0

It will be remarked that this longitude depends essentially on observations of transits made with the transit-instrument at Supply Bay, which was not in the best possible order.

G. L. T.

OBSERVATIONS OF THE TRANSIT OF VENUS.

REPORT of LIEUTENANT CYRIL CORBET, R.N., on his OBSERVATION of the TRANSIT of VENUS, 1874, December 8, at SUPPLY BAY, Royal Sound, Kerguelen Island.

[The telescope used by Lieut. Corbet was a new achromatic, by Messrs. Troughton and Simms, of 4 inches aperture. It was fitted with a solar reflecting diagonal prism, and was mounted upon a tripod stand with horizontal and vertical motions, and slow movements in both directions by means of convenient handles.]

Time by the Sidereal Clock *Baker*.	
h m s	
11. 49. 43·5.	First appearance of Venus on the Sun's disk. I do not think I could have been more than a minute late. The Sun's limb was steady, and the External Contact occurred just where I expected.
12. 1. 25·0.	Venus estimated to be half way on.
12. 14. 14·8.	Venus being rather more than three-quarters on, I first saw its following limb outside the Sun, a very faint ring of light distinctly marking it out.
12. 18. 56·1.	I could still distinctly see the following limb of Venus, faintly illuminated and nearly coinciding with the Sun's limb. No bluntness to the cusps as yet (Plate XVII., Fig. 1).

Time by the Sidereal Clock *Baker.*	
h m s	
12. 19. 26·8.	This I believe to be the moment of true contact; the cusps were just beginning to shake and get blunt { } so, and I could distinctly see Venus' second limb, with its faint light streak in perfect contact with the Sun's limb (Plate XVII., Fig. 2).
12. 19. 51·0.	At this moment the black drop, if any, for there was very little, was at its biggest or greatest stretch and about to break; but I could all along, since the last recorded time, distinctly see Venus' limb inside the Sun's, and only a slight shaky black shade between the two (Plate XVII., Fig. 3).
12. 20. 8·0.	At this moment there was no more shade between the two limbs; it disappeared.

Venus never assumed a pear shape. I did not see any brightness or wavyness to the planet's preceding limb while it was on the Sun. The illumination of the outer or following limb was a steady brownish-white light, with black speckles here and there, like irregularities on the planet's surface, quite distinct; and so it remained until all shade had disappeared between it and the Sun's limb, when it disappeared also.

I used an Airy eye-piece for the correction of atmospheric dispersion, of power 145, the solar reflecting prism, and a blue achromatised wedge. The sun never shone with full brightness. Occasionally thin filmy clouds passed over it. The wedge was not moved during the observation of ingress.

Twenty minutes or half an hour afterwards it clouded over hopelessly.

[CYRIL CORBET.]

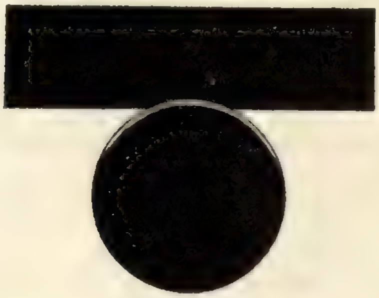
REPORT of LIEUTENANT G. E. COKE, R.N., on his OBSERVATION of the TRANSIT of VENUS, 1874, December 8, at SUPPLY BAY.

[The telescope used by Lieut. Coke was an achromatic of $3\frac{1}{4}$ inches aperture and 46 inches focal length, by Dollond, lent from the Cambridge Observatory. It was mounted, with vertical and horizontal motions, upon a tripod stand. The telescope was not fitted with any special means for viewing the Sun, beyond "dark heads" to screw on to the eye-pieces.]

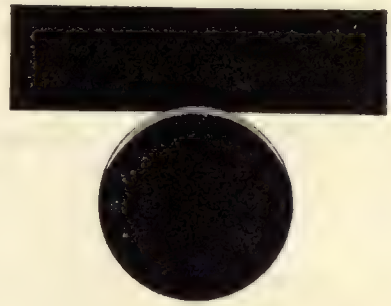
My telescope was situated about 95 yards to the east of the observatory, near the water's edge; the legs of the stand were imbedded about 6 inches in the ground, and rested upon foundations of stone. Mr. Smith Dorrien recorded the time from the sidereal chronometer S.

The sun being covered by a transparent cloud, I began to observe with a power of 61, without a dark glass.

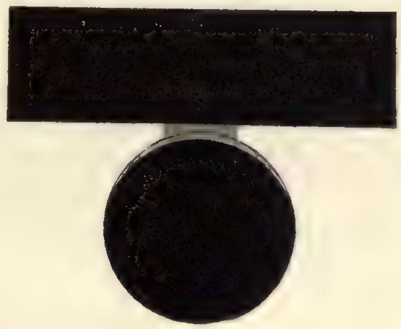
Observations at Supply Bay, Kerguelen's Island by Lieut. C. Corbet R.N. with a telescope of 4½ inches aperture, power 145.



Ingress, Fig. 1.

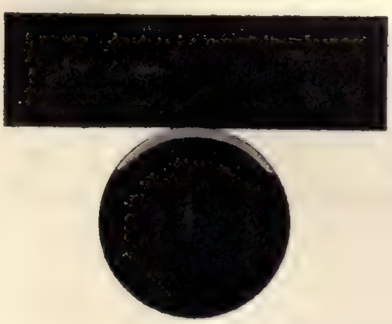


Ingress, Fig. 2.

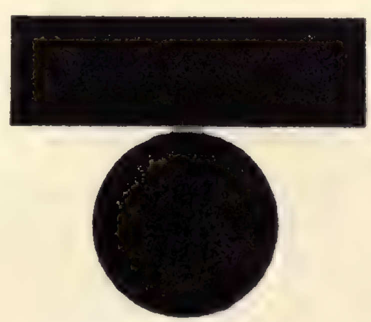


Ingress, Fig. 3.

Observations at Supply Bay, Kerguelen's Island by Lieutenant G. E. Coke, R. N, with a telescope of 3½ inches aperture, power 150.



Ingress, Fig. 4.



Ingress, Fig 5.

Dangerfield Lith 22 Bedford St Covent Garden

h m s
8. 11. 21·5. I first perceived a break in the Sun's limb. Not trustworthy. I then changed the power to 149, with the lightest red glass, and saw that the planet had encroached on the limb. As I did not follow the planet until it became unmistakeable, I have marked this observation as not trustworthy; but I believe it to be correct.

8. 40. 50·2. The planet appeared to be drawing out into the shape of a pear. I was at this instant obliged to remove the dark glass, and then I no longer saw the appearance of "drawing out." It was perfectly round, with a small portion still without the Sun's limb.

8. 43. 4·5. The planet's limb appeared to be just touching the Sun's limb, a faint ligament joining them (Plate XVII., Fig. 4). I believe this to be the actual time of contact. The limb of the planet was very distinct and beautifully illuminated, like a very young Moon. The brightness gradually disappeared towards the center of the planet. I do not remember to have noticed this illumination outside the Sun's limb. Whilst in contact there was a species of film, or shadow, for a short distance on each side of the point of contact, which joined the limbs, but did not appear to form a part of Venus, as it was much lighter than the planet. This film gradually disappeared.

8. 43. 19·5. The film or ligament getting lighter (Plate XVII., Fig. 5).

8. 43. 46·5. It disappeared. No dark glass used.

The "black drop" never properly formed; only a dark film. I consider that contact took place at $8^h. 43^m. 4^s·5$. I saw the limbs of the planet and of the Sun very distinctly.

[G. ELMSLEY COKE.]

COMPARISONS of the SIDEREAL CHRONOMETER S. with the SIDEREAL CLOCK *Baker*, by the Intervention of the SOLAR CHRONOMETER *m*, at SUPPLY BAY, 1874, December 8.

Time by Clock *Baker* at Comparison with *m*.	Adopted Correction to *Baker*.	Time by Solar Chronometer *m*. At Comparison with *Baker*.	Time by Solar Chronometer *m*. At Comparison with S.	Time by Sidereal Chronometer S. at Comparison with *m*.	Inferred Correction of Chronometer S.
h m s	s	h m s	h m s	h m s	h m s
10. 6. 26·0	− 24·85	1. 23. 30·5	1. 24. 50·0	6. 31. 9·0	+ 3. 36. 11·86
10. 29. 24·0	− 24·88	1. 46. 24·5	1. 37. 26·0	6. 43. 47·0	+ 3. 36. 12·15
12. 47. 33·0	− 25·06	4. 4. 10·5	4. 9. 26·0	9. 16. 11·50	+ 3. 36. 12·80

The observations of Ingress at Supply Bay give the following results, assuming the Latitude 49°. 30′. 56″ S., Longitude 4°. 39′. 7″·0 East of Greenwich:—

Observer.	Phenomenon observed.	Recorded Time.	Local Sidereal Time.	Greenwich Sidereal Time.	Local Tabular Distance of Centers of Sun and Venus.
		h m s	h m s	h m s	′ ″
Corbet	"True contact"	12. 19. 26·8	12. 19. 1·8	7. 39. 54·8	15. 39·47
Coke	"True contact"	8. 43. 4·5	12. 19. 17·1	7. 40. 10·1	15. 39·00
Corbet	"Black drop at greatest stretch, and about to break"	12. 19. 51·	12. 19. 26·0	7. 40. 19·0	15. 38·71
Coke	"Film getting lighter"	8. 43. 19·5	12. 19. 32·1	7. 40. 25·1	15. 38·53
Corbet	"The shade between the limbs disappeared"	12. 20. 8·	12. 19. 43·0	7. 40. 36·0	15. 38·21
Coke	"The film disappeared"	8. 43. 46·5	12. 19. 59·1	7. 40. 52·1	15. 37·73

Hence the final equations for the disappearance of the shade between the limbs, taking R = 976″·80, r = 31″·42, and mean solar parallax = $8''{\cdot}950\left(1+\frac{n}{100}\right)$—

Corbet, $+7''{\cdot}17 = -0''{\cdot}2152\, n + {\cdot}5984\, \delta\,\mathrm{R.A.} - {\cdot}7610\, \delta\,\mathrm{N.P.D.} - 0''{\cdot}0304\, \delta t - \delta \mathrm{R} + \delta r.$

Coke, $+7''{\cdot}65 = -0''{\cdot}2152\, n + {\cdot}5977\, \delta\,\mathrm{R.A.} - {\cdot}7617\, \delta\,\mathrm{N.P.D.} - 0''{\cdot}0304\, \delta t - \delta \mathrm{R} + \delta r.$

G. L. T.

TRANSIT OF VENUS, 1874.

PART IV.

EXPEDITION TO KERGUELEN ISLAND

(*continued*).

Section 3.

CHRONOMETRIC CONNECTIONS OF THE VARIOUS STATIONS IN ROYAL SOUND.

By Lieutenant CYRIL CORBET, R.N.

CONTENTS.

Chronometric Connections of the Stations in Kerguelen Island, Royal Sound.

The list of the chronometers supplied to Lieut. Corbet has been already given. On December 15, all of them being lodged on board the *Volage*, Lieut. Corbet commenced operations.

His method of proceeding was to compare the Sidereal Chronometer Z with all the others by coincidence of beats; l, m, n were then taken on shore, compared with the transit-clock of the station, carried back to the ship, and again compared with Z.

The *Volage* made the following trips :—

December 17^d. 19^h. left Observatory Bay; called at Molloy Point (American Station) 21^h. 30^m., at Thumb Peak December 18^d. 1^h., and at Supply Bay December 18^d. 5^h. 39^m.; returned to Observatory Bay December 18^d. 10^h.

December 20^d. 17^h. left Observatory Bay; arrived at Thumb Peak 20^d. 21^h., Molloy Point 21^d. 2^h.; returned to Observatory Bay at 6^h. 30^m.

December 21^d. 17^h. left Observatory Bay; arrived at Supply Bay 21^d. 21^h.; and returned to Observatory Bay 23^d. 8^h.

December 29 left Observatory Bay 17^h. 30^m.; arrived at Betsy Cove (German Station) December 30^d. 5^h.; left Betsy Cove 17^h.; returned to Observatory Bay December 31^d. 4^h.

Lieut. Corbet himself reduced the comparisons in the following manner:— From the double comparisons of l, m, n with Z, and the comparisons of the same three chronometers with the transit-clock of a station, the error of Z on local sidereal time was found, assuming an error of the transit-clock. The remaining chronometers A to H were treated as sidereal chronometers with large losing rates, and their errors on local sidereal time inferred from the comparisons with Z. The *rates* of the chronometers were inferred from the comparisons at Observatory Bay, and the deduced longitudes of the various stations were referred to Observatory Bay.

I examined Lieut. Corbet's work and found it to be correct. It was therefore only necessary to apply to his results the corrections due to the difference between the clock-errors used by him and the clock-errors finally adopted. For Molloy Point these were kindly supplied by Professor Newton, and for Betsy Cove by Dr. Auwers.

[The mass of comparisons of the chronometers A to H with Z is very great. I have not thought it necessary to print them.—G. B. A.]

CHRONOMETRIC CONNECTIONS BY LIEUT. CORBET, R.N.

COMPARISONS of the SIDEREAL CHRONOMETER Z, retained always on board H.M.S. *Volage*, with TRANSIT-CLOCKS at various Stations in ROYAL SOUND and at BETSY COVE, by the Intervention of the Portable SOLAR CHRONOMETERS *l*, *m*, and *n*.

Station, Day, and Approximate Local Mean Solar Time.	Time by the Transit-Clock of the Station at Comparison with Portable Chronometer.	Correction to the Transit-Clock, on Local Sidereal Time, adopted by Corbet.	Time by the Portable Chronometer.			Time by Z. at Comparison with Portable Chronometer.	Correction to Z., on Local Sidereal Time, inferred by Corbet.
			At Comparison with the Transit-Clock.	Name of Portable Chronometer.	At Comparison with the Sidereal Chronometer Z. on Board.		
1874.	h m s	s	h m s		h m s	h m s	h m s
OBSERVATORY BAY, Dec. 15, 9h. to 10h.	2. 48. 27·0	+14·04	5. 48. 20·0	*l*	5. 23. 51·0	10. 56. 10·0	+3. 27. 58·02
				l	6. 27. 20·5	11. 59. 50·0	+3. 27. 57·94
	2. 49. 36·0	+14·05	5. 40. 15·0	*m*	5. 15. 30·0	10. 57. 3·0	+3. 27. 57·95
				m	6. 15. 5·0	11. 56. 48·0	+3. 27. 57·81
	2. 49. 39·0	+14·05	3. 32. 6·0	*n*	3. 7. 20·0	10. 58. 5·5	+3. 27. 57·59
				n	4. 7. 17·0	11. 58. 12·0	+3. 27. 57·69
OBSERVATORY BAY, Dec. 17, 9h. to 10h.	3. 30. 30·0	+20·73	6. 22. 30·5	*l*	6. 1. 10·5	11. 41. 27·0	+3. 28. 0·23
				l	7. 15. 20·5	12. 55. 49·0	+3. 28. 0·41
	3. 32. 49·0	+20·74	6. 15. 30·5	*m*	5. 49. 14·5	11. 38. 49·0	+3. 28. 0·39
				m	7. 4. 6·0	12. 53. 53·0	+3. 28. 0·27
	3. 35. 24·0	+20·75	4. 9. 10·0	*n*	3. 42. 5·0	11. 40. 35·0	+3. 28. 0·43
				n	4. 56. 7·0	12. 54. 48·5	+3. 28. 0·68
		m s					
MOLLOY POINT, Dec. 17, 20h. to 22h.	15. 43. 25·0	+6. 22·54	6. 38. 40·5	*l*	5. 13. 50·5	10. 55. 57·0	+3. 28. 46·59
				l	7. 12. 5·0	12. 54. 31·0	+3. 28. 46·53
	15. 45. 10·0	+6. 22·60	6. 31. 5·0	*m*	5. 7. 50·0	10. 59. 17·0	+3. 28. 46·77
				m	7. 1. 30·0	12. 53. 16·0	+3. 28. 46·66
	15. 47. 37·0	+6. 22·67	4. 24. 42·0	*n*	2. 54. 30·0	10. 54. 47·0	+3. 28. 46·25
				n	4. 54. 33·0	12. 55. 9·0	+3. 28. 46·43
		s					
SUPPLY BAY, Dec. 18, 4h. to 6h.	23. 34. 37·0	−52·62	2. 22. 35·0	*l*	0. 27. 6·5	6. 10. 24·0	+3. 27. 32·89
				l	2. 53. 30·0	8. 37. 12·0	+3. 27. 32·47
	23. 35. 15·0	−52·62	2. 13. 52·0	*m*	0. 17. 15·5	6. 9. 54·0	+3. 27. 32·50
				m	2. 45. 5·0	8. 38. 8·0	+3. 27. 32·56
	23. 36. 10·5	−52·63	0. 6. 0·0	*n*	10. 6. 38·0	6. 8. 4·0	+3. 27. 32·82
				n	0. 34. 16·0	8. 36. 6·0	+3. 27. 32·38
OBSERVATORY BAY, Dec. 18, 9h. to 11h.	3. 58. 17·0	+23·84	6. 46. 20·0	*l*	6. 8. 20·0	11. 52. 34·0	+3. 28. 0·59
				l	7. 21. 20·0	1. 5. 46·0	+3. 28. 0·59
	3. 56. 38·0	+23·83	6. 35. 20·0	*m*	5. 58. 0·0	11. 51. 35·0	+3. 28. 0·62
				m	7. 12. 40·5	1. 6. 28·0	+3. 28. 0·54
	3. 59. 44·0	+23·84	4. 29. 40·0	*n*	3. 48. 20·0	11. 50. 41·0	+3. 28. 0·24
				n	5. 1. 51·0	1. 4. 23·0	+3. 28. 0·99

Station, Day, and Approximate Local Mean Solar Time.	Time by the Transit-Clock of the Station at Comparison with Portable Chronometer.	Correction to the Transit-Clock, on Local Sidereal Time, adopted by Corbet.	Time by the Portable Chronometer. At Comparison with the Transit-Clock.	Name of Portable Chronometer.	At Comparison with the Sidereal Chronometer Z. on Board.	Time by Z. at Comparison with Portable Chronometer.	Correction to Z., on Local Sidereal Time, inferred by Corbet.
1874.	h m s	s	h m s		h m s	h m s	h m s
OBSERVATORY BAY,	3. 37. 18·0	+30·00	6. 17. 40·5	*l*	5. 31. 5·5	11. 23. 4·0	+3. 28. 1·39
				l	6. 50. 30·5	0. 42. 42·0	+3. 28. 1·37
Dec. 20,	3. 36. 1·0	+30·00	6. 6. 55·0	*m*	5. 24. 0·5	11. 25. 28·0	+3. 28. 1·37
9h. to 10h.				*m*	6. 42. 20·5	0. 44. 1·0	+3. 28. 1·39
	3. 38. 22·0	+29·99	4. 0. 47·0	*n*	3. 13. 37·0	11. 23. 33·5	+3. 28. 0·92
				n	4. 32. 0·0	0. 42. 9·0	+3. 28. 0·99
		m s					
MOLLOY POINT,	20. 17. 30·0	+6. 38·43	11. 0. 27·0	*l*	9. 50. 20·5	3. 45. 2·0	+3. 28. 48·33
				l	0. 24. 50·0	6. 19. 57·0	+3. 28. 48·39
Dec. 21,	20. 19. 57·0	+6. 38·44	10. 53. 25·5	*m*	9. 40. 30·5	3. 44. 40·0	+3. 28. 48·37
1h. to 4h.				*m*	0. 16. 40·5	6. 21. 16·0	+3. 28. 48·23
	20. 23. 6·0	+6. 38·46	8. 48. 10·0	*n*	7. 31. 5·0	3. 43. 38·5	+3. 28. 48·59
				n	10. 9. 16·0	6. 22. 15·0	+3. 28. 48·49
		s					
OBSERVATORY BAY,	3. 11. 39·0	+32·67	5. 48. 10·5	*l*	5. 12. 25·0	11. 8. 19·0	+3. 28. 1·25
				l	6. 40. 11·5	0. 36. 20·0	+3. 28. 1·28
Dec. 21,	3. 9. 47·0	+32·67	5. 36. 50·0	*m*	5. 3. 55·0	11. 9. 18·0	+3. 28. 1·21
8h. to 10h.				*m*	6. 34. 5·0	0. 39. 43·0	+3. 28. 1·15
	3. 13. 24·0	+32·67	3. 32. 5·0	*n*	2. 57. 31·0	11. 11. 16·0	+3. 28. 1·13
				n	4. 23. 50·0	0. 37. 48·5	+3. 28. 1·49
SUPPLY BAY,	15. 52. 25·0	−66·30	6. 25. 40·0	*l*	5. 16. 40·5	11. 14. 34·0	+3. 27. 33·79
Dec. 21,				*l*	6. 53. 22·5	0. 51. 32·0	+3. 27. 33·77
21h. to 22h.	15. 49. 44·0	−66·29	6. 13. 30·0	*m*	*5. 13. 20·0	11. 20. 44·0	+3. 27. 33·72
				m	6. 46. 50·5	0. 54. 30·0	+3. 27. 33·74
	15. 53. 5·0	−66·30	4. 8. 33·0	*n*	3. 1. 40·0	11. 17. 21·0	+3. 27. 33·96
				n	4. 37. 20·0	0. 53. 17·0	+3. 27. 33·53
OBSERVATORY BAY,	1. 15. 33·0	+39·63	3. 44. 35·5	*l*	3. 17. 5·0	9. 20. 35·0	+3. 28. 2·59
				l	4. 45. 35·5	10. 49. 20·0	+3. 28. 2·71
Dec. 23,	1. 16. 44·0	+39·63	3. 36. 15·0	*m*	3. 8. 2·5	9. 21. 4·0	+3. 28. 2·45
6h. to 8h.				*m*	4. 35. 20·0	10. 48. 36·0	+3. 28. 2·45
	1. 18. 25·5	+39·64	1. 29. 50·0	*n*	1. 0. 44·0	9. 21. 52·0	+3. 28. 2·46
				n	2. 28. 42·0	10. 50. 4·0	+3. 28. 2·61
OBSERVATORY BAY,	4. 3. 30·0	+59·47	6. 8. 54·0	*l*	5. 33. 30·5	0. 0. 53·0	+3. 28. 7·18
				l	6. 50. 5·0	1. 17. 40·0	+3. 28. 7·20
Dec. 29,	4. 6. 35·0	+59·48	6. 2. 5·5	*m*	5. 20. 40·0	11. 57. 55·0	+3. 28. 7·10
9h. to 10h.				*m*	6. 42. 15·5	1. 19. 44·0	+3. 28. 7·16
	4. 8. 0·0	+59·48	3. 56. 15·0	*n*	3. 14. 20·0	11. 58. 51·0	+3. 28. 6·78
				n	4. 33. 50·0	1. 18. 33·0	+3. 28. 7·48

* Original $5^h. 18^m. 20^s·0$.

Station, Day, and Approximate Local Mean Solar Time.	Time by the Transit-Clock of the Station at Comparison with Portable Chronometer.	Correction to the Transit-Clock, on Local Sidereal Time, adopted by Corbet.	Time by the Portable Chronometer.			Time by Z. at Comparison with Portable Chronometer.	Correction to Z., on Local Sidereal Time, inferred by Corbet.
			At Comparison with the Transit-Clock.	Name of Portable Chronometer.	At Comparison with the Sidereal Chronometer Z. on Board.		
1874.	h m s	m s	h m s		h m s	h m s	h m s
BETSY COVE,	23. 50. 9·0	+3. 5·84	1. 43. 15·0	*m*	1. 3. 14·5	7. 43. 45·0	+3. 29. 22·70
Dec. 30,	0. 1. 26·0	+3. 5·83	1. 54. 30·0	*m*	2. 51. 10·5	9. 31. 59·0	+3. 29. 22·74
4^h. to 11^h.	23. 54. 8·0	+3. 5·84	11. 40. 5·0	*n*	10. 57. 42·0	7. 45. 21·0	+3. 29. 23·04
				n	0. 44. 49·0	9. 32. 45·0	+3. 29. 23·18
	4. 33. 6·0	+3. 5·42	6. 35. 10·0	*l*	5. 18. 40·0	11. 50. 6·0	+3. 29. 22·89
				l	7. 34. 10·0	2. 5. 58·0	+3. 29. 23·08
	4. 30. 16·0	+3. 5·41	6. 22. 35·0	*m*	5. 7. 26·0	11. 48. 37·0	+3. 29. 22·93
				m	7. 23. 5·5	2. 4. 39·0	+3. 29. 22·96
	4. 33. 42·0	+3. 5·40	4. 18. 54·0	*m*	3. 2. 30·0	11. 50. 48·5	+3. 29. 22·67
				n	5. 18. 5·0	2. 6. 45·0	+3. 29. 22·87
		s					
OBSERVATORY BAY,	22. 43. 25·0	+64·78	0. 41. 46·0	*l*	0. 2. 26·0	6. 36. 55·0	+3. 28. 8·34
				l	1. 13. 10·5	7. 47. 51·0	+3. 28. 8·42
Dec. 31,	22. 41. 58·0	+64·78	0. 30. 30·5	*m*	11. 55. 0·0	6. 39. 18·0	+3. 28. 8·39
3^h. to 5^h.				*m*	1. 4. 0·5	7. 48. 30·0	+3. 28. 8·34
	22. 45. 2·5	+64·78	10. 26. 35·0	*n*	9. 47. 0·0	6. 38. 17·5	+3. 28. 8·46
				n	10. 58. 11·0	7. 49. 40·0	+3. 28. 8·34

ERRORS and RATES of the SIDEREAL CHRONOMETER Z adopted by LIEUT. CORBET.

Approximate Local Mean Solar Time.	Time by Z.	Z Slow on Local Sidereal Time, as adopted by Corbet.	Losing Rate of Z.
At Observatory Bay.			
d h	h m	h m s	s
Dec. 15. 9	23. 28	+ 3. 27. 57·83	
17. 10	0. 18	+ 3. 28. 0·40	+ 1·25
18. 10	0. 28	+ 3. 28. 0·59	+ 0·19
20. 10	0. 3	+ 3. 28. 1·24	+ 0·33
21. 9	23. 54	+ 3. 28. 1·25	+ 0·01
23. 7	22. 5	+ 3. 28. 2·54	+ 0·67
29. 10	0. 39	+ 3. 28. 7·15	+ 0·75
31. 4	19. 20	+ 3. 28. 8·38	+ 0·69
At Supply Bay.			
Dec. 18. 5	19. 23	+ 3. 27. 32·60	...
21. 21	12. 5	+ 3. 27. 33·72	

Approximate Local Mean Solar Time.	Time by Z.	Z Slow on Local Sidereal Time, as adopted by Corbet.	Losing Rate of Z.
At Molloy Point.			
d h	h m	h m s	s
Dec. 17. 22	11. 55	+ 3. 28. 46·54	...
21. 3	17. 6	+ 3. 28. 48·40	
At Betsy Cove.			
Dec. 30. 8	22. 47	+ 3. 29. 22·87	...

From the preceding tables the following differences of longitude were inferred by Mr. Corbet:—

Chronometer.	Supply Bay *West* of Observatory Bay.		Molloy Point *East* of Observatory Bay.		Betsy Cove *East* of Observatory Bay.
	December 17.	December 21.	December 17.	December 21.	December 30.
	s	s	s	s	m s
A	27·75	28·09	46·21	47·47	1. 15·25
B	27·96	27·94	45·91	47·08	1. 15·09
C	27·81	27·81	46·06	47·27	1. 15·17
D	27·97	27·88	45·92	47·25	1. 14·94
E	27·88	27·84	46·01	47·32	1. 14·85
F	27·66	27·29	46·47	47·18	1. 15·16
G	27·99	27·66	46·02	47·11	1. 15·30
H	27·94	27·80	45·91	47·29	1. 14·83
S	..	..	..	..	1. 14·77
Z	27·96	27·87	46·05	47·16	1. 15·09
l	28·34	..	45·66	..	..
m	28·10	27·90	46·07	47·36	1. 14·70
n	..	..	..	..	..
Means	27·90	27·79	46·06	47·25	1. 15·01
	+ 0·27 (*a*)	+ 0·92 (*a*)	− 0·12 (*a*)	− 0·74 (*a*)	− 3·86 (*d*)
	− 2·01 (*b*)	− 2·51 (*b*)	+ 0·95 (*c*)	− 0·21 (*c*)	− 0·10 (*a*)
	26·16	26·22	46·89	46·30	1. 11·05

Lieut. Corbet having used approximate errors of the transit-clocks at the various stations, his longitudes have been corrected, (*a*) for Observatory Bay;

(*b*) Supply Bay; (*c*) Molloy Point; (*d*) Betsy Cove. The data for computing these corrections are the adopted errors of the various clocks. For Observatory Bay, *see* page 440; for Supply Bay, 457. For Molloy Point and Betsy Cove Professor S. Newcomb and Dr. Auwers kindly communicate the following:—

Adopted Corrections to *Negus* 1539, at Molloy Point, determined by transit observations—

	Sid. Time.	*Negus* Slow.	Daily Rate.
	h m	m s	s
1874, Dec. 12·5,	4. 54·7	+5. 55·86	
			+5·03
18·4,	4. 30·1	+6. 25·97	
			+4·44
20·5,	5. 32·7	+6. 35·05	
			+5·13
21·4,	4. 50·4	+6. 40·03	

Adopted Corrections to the Clock *Hohwü* 23, at Betsy Cove, determined by observations—

	Sid. Time.	*Hohwü* 23 Slow.	Hourly Rate.
	h	m s	s
1874, Dec. 30,	0·0	+3. 1·99	
			−0·105
	4·5	+3. 1·52	

G. L. T.

TRANSIT OF VENUS, 1874.

PART IV.

EXPEDITION TO KERGUELEN ISLAND

(*continued*).

Section 4.

OBSERVATIONS AT THUMB PEAK

By Lieutenant SOMERVILLE GOODRIDGE, R.N.

CONTENTS.

Establishment at Thumb Peak.

On the morning of 1874, December 7, civil reckoning, Lieut. Somerville Goodridge, R.N., accompanied by the Rev. A. E. Eaton (Naturalist of the Expedition) and servants, proceeded in the *Supply* from Observatory Bay towards Thumb Peak, and selected a spot at which the observation of the transit could be made. The party then went in the *Supply* to the anchorage at Three Islands Harbour, for the night; and returned early in the morning of December 8 to the selected spot, and prepared for the observation. They encamped there for the night.

The locality is fixed by the following bearings:—

S.E. part of Thumb Peak, S. 75°. 20′. W.
S.E. point of Sughin Island, N. 19°. 20′. E.
S.E. point of Sharban Island, S. 62°. 00′. E.

It is believed that these bearings are magnetic, uncorrected for Magnetic Variation.

For determination of the co-ordinates of the station in the usual form, Mr. Perry, on December 13, four days after the Transit, proceeded in the *Supply* to Thumb Peak, carrying with him De la Rue's Altazimuth and a sidereal chronometer called S, and returning on December 21. On a small hill, 215 feet high, near Lieut. Goodridge's station, a pile of stones was built for the altazimuth, and a tent placed over it. Mr. Perry observed stars near the meridian for latitude, and Sun and stars in other positions for chronometer-error. The chronometer was compared with Z of the *Supply* when she made the rounds mentioned in the last section; and from these comparisons, and those made before starting and after returning, the relation of its times to the local times at Observatory Bay was found. It will be seen shortly that no extreme accuracy is required in this process; and I have therefore thought it unnecessary to exhibit all the details. The result was, that the latitude of the station is 49°. 31′. 11″. South, and that in longitude the station is $1^{m}. 7^{s}\cdot7$ East of Observatory Bay, or $4^{h}. 40^{m}. 41^{s}\cdot2$ East of Greenwich.

The telescope used by Lieut. Goodridge is an achromatic by Dollond, of 3½ inches aperture and 46 inches focal length, on a firm tripod stand, with horizontal and vertical movements; lent from the Cambridge Observatory. It was not fitted with a diagonal reflector for feeble reflection of the Sun's rays; dark glasses were screwed on the eye-hole as required.

Time was taken from the solar chronometer Fletcher 950, of which the dial was limited to 12 hours. The observations were recorded, from Lieut. Goodridge's words, by Mr. Eaton. Before leaving the *Supply* on December 7, Fletcher 950 was compared with the solar chronometer Cribb 725 (the ship's chronometer); and on returning to the ship it was again compared. The object of these comparisons was merely to obtain assurance that Fletcher 950 had not received injury in landing from the ship and returning to it. They are as follows:—

	Fletcher 950 (h m s)		Cribb 725 (h m s)		Excess of Fletcher 950 (h m s)
Dec. 7 (civil) Fletcher 950,	11. 1. 25·0	= Cribb 725,	5. 48. 13·5 :	Excess of Fletcher 950,	5. 13. 11·5
	11. 4. 50·0		5. 51. 38·5		5. 13. 11·5
	8. 39. 50		3. 26. 35		5. 13. 15
	8. 44. 40		3. 31. 25		5. 13. 15
Dec. 9, Fletcher 950,	7. 53. 34		2. 40. 10		5. 13. 24
	7. 55. 29		2. 42. 5		5. 13. 24
	2. 52. 26		9. 39. 0·5		5. 13. 25·5
	2. 54. 31		9. 41. 5·5		5. 13. 25·5

The result appears to be satisfactory.

LIEUTENANT GOODRIDGE'S REPORT ON THE OBSERVATION OF THE TRANSIT.

The following remarks were written by me after the Transit, whilst the gear was being taken on board. [They are slight extensions of the notes written by Mr. Eaton.] The power used was 121. The times are taken from the chronometer Fletcher 950:—

Ingress.

h m s	
7. 7. 45·0, or Dec. 8, 19. 7. 45·0.	I observed the planet's limb to be complete, and much illuminated at the outer or lower edge; this was not the time of first appearance but some seconds after it.
7. 8. 19·7, or Dec. 8, 19. 8. 19·7.	Apparently geometrical contact; but as the light improved after I had given the signal, I found I was early; and fearing to lose the time of the more important phenomena by calling the time-taker's attention away and running it too close, I let the better one pass. I should say it was about 4s later.
7. 8. 46·0, or Dec. 8, 19. 8. 46·0.	I observed a considerable difference of light in the black drop; but the light being very changeable, and no appearance of a distortion such as the model produced on a bright day, I cannot think it was the same alteration of light or phenomena as was known to me as No. 2 of the four to be observed.
7. 9. 5·0, or Dec. 8, 19. 9 5·0.	This time was the instant before the cusps actually joined, the light being scarcely visible between them. There was no sudden connection, but a steady and regular meeting of the cusps. Although the light was dull, it was light compared to the other phenomena.

h m s 7. 9. 27·0, or Dec. 8, 19. 9. 27·0.	At this time a rather broad band of light was complete between the two bodies; but still a dark shadow was visible behind. The definition was not good, on account of the boiling of the limbs.
7. 9. 49·7, or Dec. 8, 19. 9. 49·7.	All appearance of shadow totally disappeared just before this.

Egress.

10. 30. 10·5, or Dec. 8, 22. 30. 10·5.	At this time a few lines or slight shadow appeared between the two limbs.
10. 30. 24·0, or Dec. 8, 22. 30. 24·0.	At this time the shadow gradually darkened, until the black drop assumed a solid appearance of the same density as the planet. Unfortunately a dark cloud came over, and I lost all further views until just before total disappearance.
11. 2. 9·5, or Dec. 8, 23. 2. 9·5.	There was just sufficient light to see it.

Having no wedge, I found great difficulty in observing the several phenomena, the light being so variable, and being unable to change the shades to suit the different lights makes me a little uncertain whether some of the times I took were only due to change of light or actual phenomena.

TIMES OF PHENOMENA OBSERVED AT THUMB PEAK.

I have ascertained that, by due attention to the various changes in chronometers and clocks, with assumption of an error of one hour in Fletcher 950 on December 10, the comparisons harmonize perfectly. They stand thus—

	Fletcher 950.		Transit-Clock.	Proportion of Intervals.
	d h m s		h m s	
1874, December	4. 2. 8. 17·5	=	18. 59. 53·0	
				1·002662
	6. 21. 33. 4·5	=	14. 35. 26·0	
				1·002660
	10. 1. 12. 52·0	=	18. 27. 18·0	
				1·002662
	11. 6. 35. 29·5	=	23. 54. 37·0	

In the following calculations we want only the second and third comparisons.

We are now to calculate the Transit-Clock Times (which relate to the Transit-Clock at Observatory Bay), the Sidereal Times for Observatory Bay, and the Sidereal Times for Greenwich, for each of the nine phenomena. The proportion of successive intervals of chronometer to corresponding intervals of Transit-Clock = 1·000000 : 1·002660.

Subject of Observation.	Fletcher 950.	Successive Intervals.	Successive Intervals for Transit-Clock.	Transit-Clock.
	d h m s	h m s	h m s	h m s
Second comparison	6. 21. 33. 4·5			14. 35. 26·0
		45. 34. 40·5 (=164080·5)	45. 41. 56·9 (=164516·9)	
1st phenomenon	8. 19. 7. 45·0 (=6. 67. 7. 45·0)			12. 17. 22·9
		34·7	34·8	
2nd phenomenon	8. 19. 8. 19·7			12. 17. 57·7
		26·3	26·4	
3rd phenomenon	8. 19. 8. 46·0			12. 18. 24·1
		19·0	19·0	
4th phenomenon	8. 19. 9. 5·0			12. 18. 43·1
		22·0	22·1	
5th phenomenon	8. 19. 9. 27·0			12. 19. 5·2
		22·7	22·8	
6th phenomenon	8. 19. 9. 49·7			12. 19. 28·0
		3. 20. 20·8 (=12020·8)	3. 20. 52·7 (=12052·7)	
7th phenomenon	8. 22. 30. 10·5			15. 40. 20·7
		13·5	13·5	
8th phenomenon	8. 22. 30. 24·0			15. 40. 34·2
		31. 45·5 (=1905·5)	31. 50·5 (=1910·5)	
9th phenomenon	8. 23. 2. 9·5			16. 12. 24·7
		26. 10. 42·5 (=94242·5)	26. 14. 53·1 (=94493·1)	
Third comparison	10. 1. 12. 52·0 (=8. 49. 12. 52·0)			18. 27. $\begin{Bmatrix}17·8\\18·0\end{Bmatrix}$

It will be remarked that the record of times in the last column does not in any way depend on the longitude of Thumb Peak, being directly referred to the Transit-Clock at Observatory Bay. The absolute times of the phenomena depend in a very slight degree on the geographical co-ordinates of Thumb Peak.

The corrections to the Transit-Clock (below) are interpolated from those in Part IV., Section 1, Tables IV. and V.

The Greenwich Sidereal Times, which are required for interpolation of tabular places of Sun and Venus, are formed by subtracting from the Observatory Bay Sidereal Times the value, $4^h. 39^m. 33^s·5$, of the eastern longitude of Observatory Bay.

The Thumb Peak Sidereal Time, which is required for computing the factor of parallax, is formed by adding $1^m. 7^s·7$, the longitude of Thumb Peak East of Observatory Bay, to the Observatory Bay Sidereal Time.

Clock Time for Correction.	Correction to Transit-Clock.	Observatory Bay Sidereal Time.	Greenwich Sidereal Time.	Thumb Peak Sidereal Time.	Local Tabular Distances of Centers of Sun and Venus.
h m	s	h m s	h m s	h m s	′ ″
6. 42	+ 52·32				
12. 18	+ 53·07	12. 18. 16·0	7. 38. 42·5	12. 19. 23·7	....
		12. 18. 50·8	7. 39. 17·3	12. 19. 58·5	15. 40·57
		12. 19. 17·2	7. 39. 43·7	12. 20. 24·9	....
		12. 19. 36·2	7. 40. 2·7	12. 20. 43·9	....
		12. 19. 58·3	7. 40. 24·8	12. 21. 6·0	....
		12. 20. 21·1	7. 40. 47·6	12. 21. 28·8	....
15. 40	+ 53·52	15. 41. 14·2	11. 1. 40·7	15. 42. 21·9	....
		15. 41. 27·7	11. 1. 54·2	15. 42. 35·4	15. 51·03
16. 12	+ 53·61	16. 13. 18·3	11. 33. 44·8	16. 14. 26·0	....
3. 58	+ 58·39				

Taking R $=$ 976″·80, r $=$ 31″·42, at Ingress, and R $=$ 976″·82, r $=$ 31″·42, at Egress, and mean solar parallax $= 8''\cdot950 \times \left(1 + \frac{n}{100}\right)$, we have—

For 2nd phenomenon, "Apparently Geometrical Contact"—

$$+4''\cdot81 = +0''\cdot2152\, n + \cdot6020\, \delta\, \text{R.A.} - \cdot7577\, \delta\, \text{N.P.D.} - 0''\cdot0304\, \delta t - \delta \text{R} + \delta r,$$

and for 8th phenomenon, "Black drop assumed a solid appearance"—

$$+4''\cdot37 = +0''\cdot1010\, n - \cdot1957\, \delta\, \text{R.A.} - \cdot9773\, \delta\, \text{N.P.D.} + 0''\cdot0317\, \delta t - \delta \text{R} + \delta r.$$

TRANSIT OF VENUS, 1874.

Part V.

EXPEDITION TO NEW ZEALAND,

UNDER

MAJOR H. S. PALMER,

ROYAL ENGINEERS.

CONTENTS.

VOYAGE, AND NAMES OF OBSERVERS.

MAJOR PALMER, R.E., accompanied by Lieutenant H. Crawford, R.N., as Assistant in the Astronomical Department, and by gentlemen whose duties were limited to the Photographic Department, sailed from Plymouth in the sailing ship *Merope* on 1874, June 27, and arrived at Port Lyttelton on September 27. The time of the voyage was employed in preparing various numerical computations, by which much trouble was subsequently saved.

THE SITE AT BURNHAM.

Major Palmer proceeded immediately to examine the country in the neighbourhood of Christchurch, for selection of a site for the Transit Observatory. In this he was assisted in every way by His Honour W. Rolleston and other resident officials. After balancing various considerations, Major PALMER fixed on BURNHAM, a place about 18 miles distant from Christchurch, and on the Southern Railway; and he states that subsequent experience gave him no reason to repent this choice. The only drawbacks to Burnham were the wind and the frequent *mirage*, which gave some little trouble, but nothing serious.

A railway, accompanied by telegraph, runs through the whole length of the great southern island of New Zealand. The plot of ground selected for the Observatory is described by Major Palmer as 800 yards N.W. of the Burnham Railway Station, and 360 yards in rear of the Industrial School, on land belonging to the Provincial Government; and here a quadrangular space about 180×133 feet was inclosed. Major Palmer satisfied himself by experiment that no sensible tremor was communicated to the Observatory ground by the passage of the heaviest trains on the railway. All the instruments were in place on October 30. For avoiding the possible effects of *mirage* the equatoreal pier and hut were raised 3 feet higher than would otherwise have been necessary. The works generally were effected by the local Government, who voluntarily undertook this expense.

CONNEXION OF THE ASTRONOMICAL STATION WITH THE TELEGRAPH.

Omitting many points of arrangement, one which is most important requires to be noticed. Wires were led from the Burnham telegraph office to the Observatory station, and thus the Observatory was placed in communication with every part of the islands at which co-operation in observation could be expected, and also with the American Observatory at Queenstown. Major Palmer also states that he was enabled to measure differences of longitude with Queenstown, Dunedin, Wellington, and Auckland, and to give time to the French war ship *Vire*, thus making connexion with the French transit party at Campbell Island.

ARRANGEMENTS FOR OBSERVATIONS AT FIVE ADDITIONAL STATIONS, AND GENERAL FAILURE.

Major Palmer finally made the following arrangements for observation at multiple stations:—Lieutenant Crawford was despatched to Naseby, in Otago, to establish a complete observatory. (I believe it was owing to this circumstance that the number of altazimuth-observations for longitude at Burnham is smaller than I had expected.) Stations at Grahamstown, Auckland, Wellington, and Dunedin were manned by private residents, Mr. H. A. Severn, Mr. T. Heale, Archdeacon Stock with Dr. Hector, and Mr. J. J. Thomson with Mr. J. Mackerrow; who placed themselves under the orders of Major Palmer, and used instruments their private property. This line of stations extended over 750 miles.

Assistance was given at the Burnham Observatory by Lieutenant Herbert Praed, R.N.

Among many detailed preparations for the transit, one was the issue of a circular to the owners and occupiers of land within a radius of three miles from Burnham, requesting them to guard against burning grass after December 1, and to keep a watch against fire on the days near December 9. These requests received universal compliance.

The preparations appear to have been very complete.

Unfortunately, the state of the weather caused an almost total failure. At Burnham the partially-imperfect observations to be detailed hereafter were made, but not a single observation was made at the other stations.

Allusion is made by Major Palmer to telegraphic time-signals with the American observers at Queenstown, but I am not aware that there is any detail of them in the papers which have reached me. [G. B. A.]

LOCATION OF THE INSTRUMENTS AT BURNHAM.

The Altazimuth was 30 feet north and 65 feet east of the Transit; the 6-inch Equatorial was 85 feet north and 37 feet east of the Transit; the Photoheliograph was 50 feet north and 25 feet west of the same instrument. The instrument piers (of bricks laid in cement) rested on concrete foundations, at depths 4 ft. 6 in. to 5 ft. 6 in. below the level of the ground. The model, artificially representing the phenomena of the Transit of Venus, was erected 400 feet from the Equatorial, on the bearing S. 60° E. The meridian mark for the Transit was distant 6054 feet, and was found to be $4''\cdot65$ East of South.

THE TRANSIT CLOCK,

originally made by Arnold for use at the Royal Observatory, was placed in the hands of Messrs. E. Dent and Co. in 1871, and was fitted with their cylindrical zinc-and-steel-pendulum, the compensation of which was severely tested at the Royal Observatory. It was suspended on a solid tripod stand of wood, which stood upon stakes driven deeply into the ground through apertures in the floor of the transit observatory.

The performance of the clock was, generally speaking, indifferent, though it happened to be going pretty well about the time of the transit. Although the tripod-legs were perfectly isolated from the floor of the hut when it was put up, it was found on dismantling the hut (January 14) that there was contact at one point between a leg of the tripod and the underneath part of the flooring, which must have been caused by settlement of the hut; and, if this happened in the early part of our stay, it might account for the irregularity of the rate. There was always much traffic about the clock, as the telegraph instruments were inside the hut. [*See* Abstract of Tables IV. and V.]

THE TRANSIT INSTRUMENT.

The Transit instrument, its piers, the hanging level, and the wooden observatory were in every respect similar to those used at Honolulu (pp. 9 *et seq.*)

The *Equatorial intervals of the wires* were found by bringing each wire in succession into coincidence with the image of the meridian mark by means

of the micrometer-screw, taking the value of one revolution of this latter at 56″·40, as follows:—

	October 28.	November 10.	December 4.
	″	″	″
Wire I.	+ 427·9	+ 428·1	+ 428·0
,, II.	+ 215·9	+ 215·7	+ 215·6
,, III.	+ 0·9	+ 0·8	+ 0·8
,, IV.	− 215·4	− 215·4	− 215·0
,, V.	− 429·1	− 429·3	− 429·4

The wires are numbered in the order in which a star above the pole will cross them with the micrometer East. The reduction from the mean to the middle wire is therefore $-0''\cdot9 \times \frac{1}{15 \sin \text{N.P.D.}}$, which has been taken $=$ $-0^{s}\cdot06$ for stars within 30° of the Equator.

The *value of one revolution of the micrometer-screw* was determined on 25 nights from close circumpolar stars, the mean value being 56″·40.

The *Collimation* of the center wire was found for the first few nights by reversal on polar stars; it was not steady. The meridian mark was then used. Finding the readings irregular, the screws about the wire frame were carefully examined (on November 5), when two of them were found to be a little loose. This was rectified, and the collimation at the same time adjusted nearly to zero ($20^{r}\cdot000$). After this it was satisfactory. The collimation was occasionally determined by means of a small reversed telescope mounted on a pier about 12 feet on the north side of the instrument. It will be sufficient to state here that, when observing stars for time, the reading of the micrometer-head was always kept at $20^{r}\cdot000$ throughout the whole series. [*See* Table I.]

The *Error of Level* of the transit axis was always determined with the hanging spirit-level. The graduation of the glass bubble was re-examined before the Expedition left England, when 30 divisions were found equal to one minute of arc, which value has been used throughout. On October 28 the value of the level graduation was tested by means of the Bohnenberger eye-piece and the known value of the micrometer-screw. One division was found equal to 2″·005. The level-error was steady, and was kept small by adjustment when necessary. It seldom exceeded 5″. The usual course was to apply the level at the beginning and end of each night's observations, before and after polar stars, before and after the Moon's transit, and generally at intervals of about an hour while observing. For the reduction

of the transits a level-error was obtained for each star, or group of stars, by combining the several determinations. [*See* Table II.]

The correction to the level-error for inequality of the size of the pivots was found on 1874, October 28, November 24, and December 3, to be $-0''\cdot05$, $-0''\cdot15$, and $-0''\cdot10$ respectively, the sign referring to "Micrometer East." The value $-0''\cdot05$ was used up to November 23, $-0''\cdot15$ to December 2, and $-0''\cdot10$ on and after December 3.

The *Error of Azimuth* was determined from observations of the 8 close southern circumpolar stars in Mr. Stone's list, 1874, February 28 (*see* Rodriguez Observations, page 356). No other stars were used. On six occasions the error of azimuth was obtained from the Meridian Mark, assuming this latter to be $4''\cdot65$ East of true South. The changes of the azimuthal position, if at times somewhat rapid, were pretty regular in one direction during the first three weeks of November, namely, in that direction which would correspond with a southerly movement of the east pier. After this there were two or three sudden changes, from time to time, connected apparently with heavy rain-fall, but no further steady progressive movement in one direction. Rain seemed to act immediately on the azimuth without affecting the level. The azimuth error was reduced by the adjusting screws on November 2, 18, and December 10; on October 27 it was disturbed by touching the level adjustment. [*See* Table III.]

The *Meridian Mark* was erected October 26, about 6054 feet south of the Transit instrument. It consisted of a small brick pier, about 2 feet square and 7 feet high, to the north face of which was cemented an iron plate 2 feet 6 inches long, and 1 foot 6 inches broad, with top and bottom flanges entering 5 or 6 inches into the brickwork. The face of the plate was painted black, with a diagonal cross of white lines half an inch wide. At the exact center of this cross a circular hole one-third of an inch in diameter was drilled through the plate, and behind it a chamber was left in the pier sufficiently large to hold a railway signal lamp, which was trimmed and lighted at dusk every night and which would burn for six hours. The zenith distance of the mark as measured by the transit instrument was $90^\circ. 15'$. At night, when illuminated, it appeared like a star of the fifth or sixth magnitude. It has not been removed. The iron plate was shifted $3\frac{1}{2}$ inches to the East on October 28.

The following are the determinations of the absolute azimuth of the meridian mark, obtained by comparing the observations of it when illumi-

nated at night with those of the close circumpolar stars observed for azimuth error :—

	Mark East of South.		Mark East of South.
	″		″
1874, October 28	3·1	1874, December 2	3·2
30	3·9	3	2·0
November 2	2·2	6	4·9
3	7·2	10	9·1
7	4·7	18	5·0
8	1·6	19	4·3
12	7·3	26	4·5
15	1·8	27	4·0
18	5·9	28	4·4
20	7·0	29	6·7
21	5·6	1875, January 5	4·9
23	4·5	9	3·4
27	4·4	11	8·7
29	4·8	12	3·5
30	4·4	13	4·1
December 1	5·2		

The adopted position of the meridian mark is 4″·65 East of South.

The observations of the mark are entered in Table III.; each micrometer reading there given represents the mean of five or more bisections of the mark, generally when illuminated at night.

TRANSITS OF STARS AND OF THE MOON OBSERVED AT BURNHAM.

(*Abstract of Tables IV. and V.*)

The transits of stars observed on all days when the Moon was also observed, either with the Transit instrument or with the Altazimuth, are given in the same detail as for other stations. The observations were completely reduced by Major Palmer.

The transit-micrometer was kept at 20ʳ·000 for all clock stars, and the bisections of circumpolar stars with the center wire were so taken that the mean micrometer-reading was 20ʳ·000.

For the Moon, the transit was corrected in the same manner as a transit of a star. A correction was then applied for the Moon's motion, which was obtained by multiplying the sum of the instrumental corrections by the Moon's motion in R.A. in one second of longitude.

THE ALTAZIMUTH INSTRUMENT AND OBSERVATIONS.

The *Altazimuth* used at Burnham was made by Messrs. Troughton and Simms about the year 1864 for the Royal Observatory. It has two vertical and one horizontal circles of 15 inches diameter, divided to 5′, each read by four micrometer-microscopes. The object-glass is of $2\frac{1}{4}$ inches diameter and 27 inches focal length. The telescope and horizontal axis are constructed to give what is known as the axis-view. A rectangular prism of total reflexion is placed at the point of intersection of the optic axis of the object-glass with the horizontal axis, so as to reflect the cone of light formed by the object-glass horizontally into one of the pivots to which the eye-piece and reticule are fitted. The weight of the half-telescope carrying the object-gass is counterpoised. The illumination of the field of view is effected by lamp-light passing through the opposite pivot and through the center of the prism mentioned above, a very small rectangular prism being cemented to the center of the inclined face of the larger prism, and, therefore, exactly in the line of pivots, to allow the light to pass through. There are five vertical and five horizontal wires, the latter having larger intervals than the former.

The microscopes of the horizontal circle are supported by radial arms cast in one with the rotating body of the instrument, and are perfectly rigid. There are two zenith-distance levels and two levels attached to the horizontal circle. A striding level, similar to those used with Transit instruments, is used for determining the inclination of the axis. The value of the divisions of this level were tested before leaving England, when 50 divisions were found equal to one minute of arc, which was the former value.

On unpacking the instrument at Burnham, one of the pivots, which were of hard white steel, was found to be badly rusted, apparently from a piece of paper having been wrapped round it; for the other pivot, without paper, was quite bright. A small spider had been at work among the webs of the reticule, but without doing any real injury to them. The pivot having been cleaned as well as possible, the instrument was mounted, on October 16, on a pier of masonry.

The inequality of the pivots of the horizontal axis was approximately determined on December 11. The level error was determined five times with the axis in each position; the resulting correction to the level error found by the striding level, 0″·62, positive with "lamp right," has been applied throughout.

The horizontal intervals of the vertical wires were found on December 21, by means of the transit meridian-mark before described. Ten bisections of the mark were made with each wire (five in each position of the instrument), the horizontal circle being read each time. There being no imperfect horizontal transits observed, the intervals are only required in order that the distance of the mean wire from the center wire may be known.

The following are the circle-readings corrected for runs :—

Wire.	Circle-reading, Lamp Left.	Circle-reading, Lamp Right.
	° ′ ″	° ′ ″
I.	104. 5. 19·95	283. 53. 7·75
II.	104. 1. 41·85	283. 56. 45·50
III.	103. 58. 9·85	284. 0. 17·49
IV........	103. 54. 46·80	284. 3. 41·85
V.........	103. 51. 15·90	284. 7. 10·83
Mean	103. 58. 14·87	284. 0. 12·68

The wires are numbered as seen from left to right with lamp left. The circle-reading for the mean wire has been taken as 4″·92 greater than for the center wire with lamp left.

The corrections for runs of micrometers of the horizontal circle were found as below. Each determination is the mean of four or six at different parts of the circle, made usually on the morning after a night's work.

Day.		Observer.	Correction for Runs for 100″.
1874.			″
October	23	C	− 0·39
	27	D	− 0·38
	28	C	− 0·44
November	15	D	− 0·43
	19	C	− 0·46
	20	D	− 0·30
December	28	D	− 0·38

The vertical circle of the Altazimuth is 15 inches in diameter, read by four micrometer-microscopes, which are attached by binding-thumb-screws to a movable flat ring of bronze, which is screwed at four points to arms projecting from the frame of the instrument; a form of mounting which, in Captain Tupman's opinion, is not conducive to the steadiness of the microscopes, or to their easy adjustment.

The corrections for runs of the microscope-micrometers, for an arc of 100″, are as follows. They are the means of determinations at four or six different parts of the circle.

Day.		Observer.	Correction for Runs for 100″.
1874.			″
October	22	P	− 0·28
	23	C	− 0·43
	27	D	− 0·41
	31	C	− 0·30
November	10	D	− 0·48
	19	C	− 0·41
1875.			
January	7	C	− 0·35
	12	C	− 0·46

LATITUDE OF BURNHAM.

Observations of zenith distance of 28 stars were taken with face of the vertical circle alternately east and west, and all corrections proper for such observations were applied. The North Polar Distances of the stars were taken, as far as possible, from the Greenwich Catalogue of 2260 Stars for 1864. For stars near the South Pole the polar distances were taken from the Cape Catalogue 1860, and the Melbourne Catalogue 1870. The results were as follows :—

Co-latitude of Burnham—

	° ′ ″
By 19 stars North of the Zenith	46. 23. 11·59
9 stars South of the Zenith	46. 23. 12·15

	° ′ ″	
Adopted Co-latitude	46. 23. 11·9	
,, Latitude	43. 36. 48·1	South.

OBSERVATIONS OF AZIMUTH WITH THE ALTAZIMUTH.

In making an observation, the instrument is clamped in azimuth, and the zenith-distance slow-motion is used to make the transit of the object take place over the middle of each vertical wire. The striding level is applied in both positions to determine the error of level, after the four microscopes of the horizontal circle have been read. The instrument is then reversed, another transit observed in a similar manner, the circle read, and the level

error again determined with the striding level, thus completing one observation.

Every observation of the Moon is accompanied by one of a star as near the Moon as possible. The error of collimation and zero of azimuth are deduced from the observations of the stars. The error of collimation is not required to be known with great accuracy, but as this is an instrumental quantity which cannot be subject to great changes, its determinations afford a test of the general accuracy of the observations. The zero of azimuth will of course be affected by any error that may exist in the local time obtained by another observer with the Transit instrument and transferred to the Altazimuth Clock; but the adoption of the observed zero of azimuth on each night practically makes the observations differential.

To the mean of the clock times of transit over the five vertical wires, the clock correction is to be applied; it is taken from the Abstract of Tables IV. and V. Then putting l for the error of level of the horizontal axis determined by the striding spirit-level, the correction to the circle-reading for error of level is—

$$+ \, l \, . \cot \text{Z.D.}$$

The correction for error of collimation (c) is—

$$+ \, c \, . \operatorname{cosec} \text{Z.D.}$$

By applying the zero of azimuth to the circle reading thus corrected, the observed azimuth is obtained. The approximate apparent zenith distance is then computed.

The *Greenwich Mean Solar Time* corresponding to the local sidereal time of each observation is then found on two assumptions of longitude, viz., $11^h. 29^m. 0^s.$ and $11^h. 30^m. 0^s.$ East of Greenwich. The Apparent Right Ascension and North Polar Distance of the Moon's center are then interpolated with second differences from the hourly ephemeris in the *Nautical Almanac*, and corrected for errors of the tables by the quantities given in the Appendix. The semidiameter is also interpolated from the *Nautical Almanac*.

With the local sidereal time of observation and each of these sets of elements, and with the latitude already found, the tabular azimuth of the limb has been computed by the Normal-centric method, which is explained and all the formulæ given in the Introductions to recent volumes of the Greenwich Observations. If the two tabular azimuths corresponding to the one local time be nearly identical, the position of the Moon was not favourable, and the observation is of no value; but if there be a difference con-

siderably greater than the degree of accuracy with which the instrument is capable of measuring azimuths, the true longitude can be inferred by a simple proportion. Of all methods of obtaining the longitude by means of the Moon's motion, that of observed azimuths is the most troublesome. [It is, however, used successfully at Kerguelen and at Burnham, as far as the number of observations permits.—G. B. A.]

[For the same reasons as in the similar stages of operations in Part III. and Part IV., I have suppressed the details of the Altazimuth Reductions in this Part.—G. B. A.]

Table VII. contains the mean result for longitudes of Burnham, inferred from the observations of each day exhibited separately for the preceding and following limbs of the Moon.

ON THE LONGITUDE OF BURNHAM.

The Meridional Transits of the Moon, Table VI., give $11^h. 29^m. 10^s{\cdot}6$.

The Observed Azimuths, Table VII., give $11^h. 29^m. 20^s{\cdot}5$.

The latter observations are less numerous, and probably inferior in quality. If we give weights to the results in the proportion of 3 : 1, we shall obtain for final longitude of Burnham—

$11^h. 29^m. 13^s{\cdot}1$ East.

OBSERVATIONS OF THE INGRESS OF VENUS, 1874, DECEMBER 8 (GREENWICH RECKONING), DECEMBER 9 (NEW ZEALAND RECKONING).

After describing the preparations for observation, and the unfavorable character of the weather preceding the Ingress, Major Palmer proceeds as follows:—

The first glimpse after first contact was obtained at $18^h. 41^m. 36^s{\cdot}25$ sidereal; the planet was then seen to have advanced apparently about three-eighths of her diameter on the Sun. Both Sun and planet could only be just made out through the clouds, without any coloured shade to the eye-piece. Having adjusted to center of field, I now exchanged the eye-piece for the double-image micrometer, and between this and $18^h. 54^m.$ made a dozen attempts to effect measures of diameters and cusps, in the few brief glimpses (never exceeding 8 to 10 seconds) which were now and then afforded by partial rifts in the dense masses of cloud. My efforts, however, were quite unavailing.

Besides the loss of the already faint light, which rendered the images scarcely discernible, before adjustment for position and equal brightness of images could be made the Sun was gone from view. This happened at each re-appearance; there was never time (generally the appearances lasted but four or five seconds) to adjust for an accurate measure in the middle of the field, even had such measures been possible with the imperfect light—still less to make a measure. I am certain, moreover, that even had the light remained steady at its maximum brightness, it was too dim, and the clouds were moving too quickly and confusingly across the Sun, for any measures of value to have been secured. I was quite cool, and prepared to make the most of every opportunity.

The whole time before internal contact I never used a coloured glass, and had difficulty in making out the Sun without one.

At $18^h. 49^m. 21^s{\cdot}26$ sidereal the cusps subtended about 95°. at planet's center, as estimated in a passing glimpse.

At $18^h. 53^m. 6^s{\cdot}26$ sidereal another glimpse showed cusps about three-fifths of a diameter apart—pretty sharp. An ordinary eye-piece was now inserted. In glimpses—

	h m s	
At	18. 55. 46·27,	cusps about half a diameter apart.
At	18. 57. 16·27,	„ one-third „

At $18^h. 58^m. 46^s{\cdot}27$ the Sun showed again, when the cusps were about one-twentieth of a diameter apart, and connected by a dimly marked ligament, not nearly so sharp as the " black-drop " of the model in full sunlight.

At $18^h. 58^m. 50^s{\cdot}07$, as far as could be judged, the ligament seemed to undergo a change in depth of colour, but clouds prevented me from seeing whether any streak of light connecting cusps played across it. This is spoken of in the little table which follows as " the first light on ligament."

My last sight of the planet was at $18^h. 58^m. 53^s{\cdot}27$, at which moment I *thought* I saw a very slight wavering streak of light, though the cusps (now very close) had not fairly met.

I judged that it wanted about five seconds to complete separation of limbs. I counted the clock-ticks for five seconds, and gave a signal for an estimated contact at $18^h. 58^m. 58^s{\cdot}27$.

The Sun did not appear again until about $19^h. 13^m.$, by which time the planet appeared to be about half its own diameter within the limb. I again

inserted the double-image micrometer, and got, at intervals during about 14 minutes, 13 measures of distances of limbs. These were caught in passing glimpses; but, owing to incessant variation in the Sun's brightness, they were very irregular, and can be of little use. The Sun was never quite clear. I append a list of times and measures; but, as there was no opportunity of measuring diameters for zero of micrometer, the measures can only be referred to the zeros as determined from the model the day before and the day after the transit.

At about $19^h. 28^m.$ the Sun was lost in a large mass of cloud, and further measures of diameters were impracticable till too late to be of any use. I therefore again compared the equatorial and transit clocks. Rain set in just as this was finished and lasted till $21^h. 40^m.$, and the Sun never appeared again till 10 minutes after the fourth contact, when it shone brightly until nearly sunset.

Nothing peculiar was noticed in the appearances near or after second contact. They were just those for which the model when observed on a dull day had prepared us; though a certain amount of atmospheric vibration made the Sun's limb and the planet rather tremulous. In good sunlight there is no doubt that satisfactory micrometer-measures and satisfactory observations of contact might have been made. The planet was intensely black, with a sharp black outline.

[It is remarkable that there is no allusion to a silvery ring round Venus.—G. B. A.]

EPITOME OF THE OBSERVATIONS OF THE TRANSIT OF VENUS, BURNHAM, N. Z., 1874, DECEMBER 9.

Clock times were taken by Dent No. 2017, compared with the Transit-Circle Arnold No. 2 before and after observations.

At $17^h. 44^m.$ Dent slow of sidereal time at transit hut = $+ 6^s{\cdot}13$.
„ 19. 50. „ „ „ = $+ 6{\cdot}32$.
(The correction from transit hut to equatorial hut is = $+ 0{\cdot}03$.)

Therefore at $17^h. 44^m.$ Dent slow of sidereal time at equatorial hut = $+ 6^s{\cdot}16$.
„ 19. 50. „ „ „ = $+ 6{\cdot}35$.

The Adopted Longitude of Burnham is $11^h. 29^m. 13^s{\cdot}1$ East of Greenwich.

Observations.	Times by Dent 2017.	Dent Slow.	Local Sidereal Times.	Greenwich id ereal Times.
	h m s	s	h m s	h m s
First sight of planet at Ingress	18. 41. 30·0	+ 6·25	18. 41. 36·25	7. 12. 23·2
Cusps subtend about 95° at planet's center	18. 49. 15·0	+ 6·26	18. 49. 21·26	7. 20. 8·2
Cusps about $\frac{2}{3}$ of planet's diameter apart .	18. 53. 0·0	+ 6·26	18. 53. 6·26	7. 23. 53·2
„ $\frac{1}{2}$ „ „ .	18. 55. 40·0	+ 6·27	18. 55. 46·27	7. 26. 33·2
„ $\frac{1}{3}$ „ „ .	18. 57. 10·0	+ 6·27	18. 57. 16·27	7. 28. 3·2
„ $\frac{1}{20}$ „ „ .	18. 58. 40·0	+ 6·27	18. 58. 46·27	7. 29. 33·2
First light upon ligament	18. 58. 43·8	+ 6·27	18. 58. 50·07	7. 29. 37·0
Last sight of planet	18. 58. 47·0	+ 6·27	18. 58. 53·27	7. 29. 40·2
Estimated junction of cusps	18. 58. 52·0	+ 6·27	18. 58. 58·27	7. 29. 45·2

For the measures made with the double-image micrometer—

December 8. Measures of diameter on model. No sunlight. Time 21^h. 30^m. sidereal.

r	r
6·502	13·368
·566	·371
·551	·379
·551	·364
·535	·362
·525	·370
·532	·356
·519	·358
·521	·359
·523	·350
·525	·351
·572	·326
·572	·344
·554	·348
·581	·320
6·542	13·355

$$\frac{6^{r}\cdot542 + 13^{r}\cdot355}{2} = 9^{r}\cdot948$$ = reading at coincidence of images.

December 10. Measures of diameter on model. No sunlight. Time 0^h. 30^m. sidereal.

r	r
6·545	13·392
·543	·387
·555	·395
·536	·402
·549	·401
·533	·405
·533	·409
6·542	13·399

$$\frac{6^{r}\cdot542 + 13^{r}\cdot399}{2} = 9^{r}\cdot970$$

= reading at coincidence of images.

December 9. Distances of limbs after Ingress, measured with the double-image micrometer—

Micrometer Measures.	Times, Dent 2017.	Dent Slow.	Sidereal Times.	Remarks.
r	h m s	s	h m s	
8·646	19. 14. 5·5	+ 6·30	19. 14. 11·80	
·324	15. 44·0	+ 6·30	15. 50·30	
·263	16. 18·8	+ 6·30	16. 25·10	
·206	16. 35·2	+ 6·30	16. 41·50	
·137	17. 28·8	+ 6·30	17. 35·10	Very faint.
·091	18. 23·8	+ 6·30	18. 30·10	
·073	18. 44·5	+ 6·30	18. 50·80	Cloudy.
·052	19. 11·0	+ 6·30	19. 17·30	Cloudy.
7·958	20. 17·2	+ 6·31	20. 23·51	
·856	20. 44·0	+ 6·31	20. 50·31	
·872	21. 4·8	+ 6·31	21. 11·11	Cloudy.
·921	21. 22·0	+ 6·31	21. 28·31	Cloudy.
·448	27. 11·2	+ 6·32	27. 17·52	

[It does not appear that the value of the micrometer-scale has been ascertained, and the observations above, as a mass, are useless. If it is desired to utilize only the earlier observations, a value sufficiently accurate may be found from comparison of the earlier with the later, referring also to the co-efficient of $\delta\, t$ in the final equation.—G. B. A.]

For the Greenwich sidereal time, $7^h.\ 29^m.\ 41^s{\cdot}3$, Major Tupman has computed the final equation as follows:—

Interpolating for the Greenwich sidereal time, $7^h.\ 29^m.\ 41^s{\cdot}3$, the N. P. D. and Differential R. A. of Sun and planet, and computing from these elements the Tabular Distance of centers $(15'.\ 38''{\cdot}25 - ''{\cdot}0319\ \delta\, t + ''{\cdot}0141\ \delta\, n)$, and equating this with the interpolated distance between centers or difference of semidiameters $(15'.\ 45''{\cdot}38 + \delta\, R - \delta\, r)$ we obtain the final equation—

$$+ 7''{\cdot}13 = + {\cdot}0141\ \delta\, n + {\cdot}6174\ \delta\ \mathrm{R.A.} - {\cdot}7429\ \delta\ \mathrm{N.P.D.} - 0''{\cdot}0319\ \delta\, t - \delta\, \mathrm{R} + \delta\, r.$$

The equations for the Greenwich sidereal times $7^h.\ 29^m.\ 40^s{\cdot}2$ and $7^h.\ 29^m.\ 45^s{\cdot}2$ will be found by making $\delta\, t = -1{\cdot}1$ and $+3{\cdot}9$ respectively.

[G. B. A.]

OBSERVATIONS

AT

BURNHAM, NEW ZEALAND,

IN TABULAR ARRANGEMENT.

TABLE I.—ERROR of COLLIMATION of the CENTER WIRE of the TRANSIT INSTRUMENT, corresponding to the Micrometer Reading $20^{r}\cdot000$.

(The signs are those for Micrometer *East*.)

Day.	Observer.	Object observed.	Collimation Error. Micrometer $20^{r}\cdot000$ E.
1874.			"
October 20	P	z Octantis	+ 2·60
21	D	o Octantis	+ 2·31
22	C	τ Octantis	+ 2·20
23	P	,,	+ 3·31
26	P	Meridian Mark	+ 1·47
28	C	,,	+ 0·62
30	D	,,	+ 1·98
November 1	P	,,	+ 2·67
2	D	,,	+ 2·70
3	C	,,	+ 1·47
4	P	,,	+ 3·50 + 2·93
6	C	o Octantis	− 0·15
7	D	Meridian Mark	− 0·11
8	P	,,	+ 1·92
9	C	,,	+ 2·59
10	C	,,	+ 1·41 + 1·80
11	P	M. M. very unsteady	(− 5·13)
12	C	Meridian Mark	+ 0·28
15	P	,,	+ 0·68 + 0·96
		Collimator	+ 0·68 + 0·45
18	D	M. Mark	+ 0·56
20	P	,,	+ 0·62
		Collimator	+ 0·62
21	P	M. Mark	0·00
		Collimator	+ 1·18
23	P	M. Mark	+ 1·44
		Collimator	+ 1·21
25	D	,,	+ 1·07
27	D	M. Mark	+ 1·02
28	P	,,	+ 0·90
		Collimator	+ 1·35
29	D	M. Mark	+ 1·41
1874.			"
November 30	P	M. Mark	+ 1·97
		Collimator	+ 1·58
December 1	P	M. Mark	+ 1·86
		Collimator	+ 1·41
2	P	M. Mark	+ 2·43
		Collimator	+ 2·03
3	P	M. Mark	+ 2·43
4	P	,,	+ 2·09
5	P	Collimator	+ 2·70
		M. Mark	+ 2·43
6	D	,,	+ 2·26
8	D	,,	+ 2·76
9	P	,,	+ 3·04
10	D	,,	+ 3·00
18	C	,,	+ 1·58
19	D	,,	+ 0·50 + 0·34
20	C	Collimator	+ 0·96
26	D	M. Mark	+ 2·42
27	C	,,	+ 1·80
28	D	,,	+ 0·30
		Collimator	+ 0·70
29	P	,,	− 0·34
31	P	M. Mark	− 0·51
1875.			
January 5	P	M. Mark	+ 0·17
6	P	,,	− 0·85
9	C	,,	− 0·68
11	P	,,	− 0·08 + 0·23
12	P	,,	+ 0·34 − 0·34
13	P	,,	+ 0·11 + 0·06

TABLE II.—LEVEL ERROR of the TRANSIT INSTRUMENT at BURNHAM, determined by SPIRIT LEVEL.

[The sign + indicates that the East Pivot is low.]

Day.		Observer.	Sidereal Time of Level Determination.	Position of Micrometer.	Level Error corrected for Inequality of Pivots.
1874.			h m		″
October	20	C	0. 50	W	− 0·75
			1. 40	W	− 0·95
		P	2. 12	E	− 2·85
			2. 35	W	− 1·15
	21	D	21. 40	W	+ 3·65
			22. 0	W	+ 5·10
			22. 35	W	+ 5·45
			22. 50	W	+ 5·40
			0. 0	E	+ 3·20
			0. 25	W	+ 4·20
	22	C	21. 30	E	+ 3·95
			22. 40	E	+ 4·45
			23. 17	W	+ 6·05
			0. 5	W	+ 5·55
	23	P	22. 0	W	+ 7·45
			22. 15	W	+ 9·15
			22. 50	W	+ 8·60
			23. 20	E	+ 7·50
			0. 0	E	+ 7·05
			0. 30	E	+ 6·85
	26	P	1. 40	W	+ 3·00
			2. 15	W	+ 3·00
			2. 40	W	+ 2·30
			2. 56	W	+ 1·35
			3. 25	W	+ 2·30
	28	C	4. 28	E	+ 2·95
			5. 0	E	+ 1·95
			5. 25	W	+ 2·30
			5. 50	W	+ 2·85
	30	D	21. 45	W	+ 4·90
			23. 10	W	+ 4·80
			0. 7	E	+ 3·50
			0. 31	E	+ 3·70
1874.			h m		″
November	1	P	23. 50	E	+ 8·75
	2	D	23. 53	E	− 3·40
			0. 15	E	− 3·60
			0. 35	E	− 4·15
			1. 10	W	− 2·60
	3	C	0. 5	E	− 3·05
			1. 0	W	− 1·95
			1. 10	W	− 0·15
	4	P	23. 45	W	+ 1·95
			0. 5	W	+ 1·65
			1. 20	W	+ 1·50
			2. 15	E	+ 1·05
	5	D	12. 25	W	+ 0·40
	6	C	23. 45	W	+ 1·80
			0. 25	E	+ 1·30
			0. 45	E	+ 0·65
	7	D	23. 55	E	+ 4·60
			0. 15	E	+ 3·75
			1. 10	E	+ 3·45
	8	P	23. 15	W	+ 3·65
			0. 5	E	+ 1·85
			0. 40	E	+ 2·75
		C	0. 0	E	+ 3·05
			1. 10	E	+ 3·20
	10	P	18. 45	W	− 1·65
	11	P	2. 20	W	− 1·70
			2. 35	W	− 1·00
			3. 40	E	− 3·00
	12	C	0. 40	W	− 0·35
			1. 10	W	− 0·25

Table II.—Level Error of the Transit Instrument—*continued.*

Day.		Observer.	Sidereal Time of Level Determination.	Position of Micrometer.	Level Error corrected for Inequality of Pivots.
1874.			h m		″
November	12	C	1. 30	E	− 0·50
			2. 5	E	− 1·30
			2. 40	E	− 1·80
	14	D	14. 35	E	− 3·70
	15	P	0. 0	E	− 3·40
			0. 35	E	− 4·25
			1. 30	W	− 3·50
	16	D	14. 44	W	− 4·85
	17	D	12. 48	E	− 4·55
	18	D	22. 50	W	− 4·40
			22. 57	W	− 4·00
			0. 14	W	− 4·25
			0. 35	W	− 4·00
			1. 25	E	− 5·85
	19	D	13. 56	W	− 0·60
	20	P	23. 25	E	− 0·45
			0. 5	W	− 0·05
			0. 22	W	− 0·45
			0. 45	W	+ 0·75
			1. 22	W	+ 0·50
	21	P	0. 0	W	+ 1·50
			0. 45	W	+ 2·00
	22	D	2. 38	W	+ 2·55
	23	P	2. 0	E	+ 5·65
			2. 15	E	+ 5·95
			2. 40	E	+ 5·70
			3. 30	W	+ 5·80
			3. 40	W	+ 5·80
	24	D	3. 13	E	+ 5·45
1874.			h m		″
November	25	D	0. 20	E	+ 4·45
			0. 40	E	+ 3·70
			1. 24	W	+ 6·00
			1. 52	W	+ 6·55
			3. 24	E	+ 2·30
			5. 18	E	+ 3·55
			5. 58	E	+ 2·80
			6. 25	E	+ 3·25
	26	D	15. 3	E	+ 5·65
	27	D	0. 0	W	+ 6·30
			0. 40	W	+ 6·40
			1. 36	W	+ 6·85
			1. 40	E	+ 5·55
			2. 10	E	+ 4·00
			2. 37	E	+ 4·25
			7. 30 ?	E	+ 3·70
			8. 10	E	+ 2·45
	28	P	0. 15	E	+ 2·90
			0. 45	E	+ 3·15
			2. 0	W	+ 2·00
	29	D	0. 0	W	+ 2·25
			...	W	+ 3·90
			1. 20	W	+ 4·45
			1. 44	E	+ 2·20
			2. 15	E	+ 1·70
			2. 30 ?	E	+ 1·35
	30	P	0. 15	W	+ 1·35
			0. 40	W	+ 1·10
			1. 30	W	+ 1·90
			2. 15	W	+ 1·30
			2. 40	W	+ 1·30
December	1	P	0. 15	W	+ 1·95
			0. 50	W	+ 3·90
			1. 30	E	+ 0·60
			2. 15	W	+ 1·95
			2. 40	W	+ 2·50

Table II.—Level Error of the Transit Instrument—*continued.*

Day.		Observer.	Sidereal Time of Level Determination.	Position of Micrometer.	Level Error corrected for Inequality of Pivots.
1874.			h m		″
December	2	P	2. 15	E	+ 0·30
			2. 40	E	+ 0·10
			3. 45	W	+ 1·65
			4. 15	W	+ 1·95
	3	P	2. 15	E	+ 1·65
			2. 40	E	+ 0·80
	5	P	2. 40	E	+ 2·85
			4. 15	W	+ 2·50
	6	D	4. 40	W	+ 4·85
			5. 12	W	+ 3·55
			5. 25	E	+ 2·90
			6. 0	E	+ 1·25
			6. 15	E	+ 1·25
	8	D	3. 50	W	+ 2·35
			4. 55	W	+ 2·20
			5. 43	W	+ 3·15
			6. 20	W	+ 4·05
			7. 2	W	+ 3·95
			7. 25	E	+ 1·90
			7. 55	E	+ 1·50
	9	P	2. 40	E	− 0·40
	10	D	2. 0	W	+ 2·60
			2. 14	W	+ 1·60
			2. 35	W	+ 2·80
			3. 7	W	+ 2·35
			3. 29	E	+ 1·45
	18	C	1. 55	W	− 4·90
			2. 15	W	− 2·90
			2. 40	W	− 4·15
			3. 0	E	− 5·35
	19	D	1. 30	E	− 5·15
			2. 0	E	− 5·50
			2. 10	E	− 5·15
			2. 44	E	− 5·25
1874.			h m		″
December	19	D	3. 30	E	− 3·70
			5. 10	W	− 3·60
			6. 0	W	− 3·20
			6. 20	W	− 3·65
	20	C	2. 3	W	− 5·55
			2. 35	W	− 4·80
			3. 5	W	− 3·63
			3. 45	W	− 3·25
			3. 55	E	− 5·10
			4. 25	E	− 5·10
			4. 33	W	− 5·25
	26	D	2. 45	E	− 2·00
			3. 10	E	− 3·60
			3. 25	W	− 2·10
			6. 15	W	− 1·55
			6. 45	W	− 0·65
			7. 15	E	− 1·85
			7. 55	E	− 2·10
			8. 30	E	− 3·60
	27	C	6. 25	E	− 1·25
			6. 55	E	− 3·10
			7. 15	W	− 0·25
			7. 35	W	− 1·15
	28	D	2. 45	W	+ 0·70
			3. 8	W	− 0·60
			3. 30	E	− 1·55
			3. 44	E	− 1·65
			5. 40	E	− 2·50
			6. 0	E	− 2·25
			6. 30	E	− 2·45
	29	P	3. 45	E	− 1·90
			4. 10	E	− 2·65
			5. 52	W	− 0·45
			6. 30	W	+ 0·10

Table II.—Level Error of the Transit Instrument—*continued.*

Day.		Observer.	Sidereal Time of Level Determination.	Position of Micrometer.	Level Error corrected for Inequality of Pivots.	Day.		Observer	Sidereal Time of Level Determination.	Position of Micrometer.	Level Error corrected for Inequality of Pivots.
1875.			h m		″	1875.			h m		″
January	5	P	4. 15	W	+ 5·75	January	11	P	5. 20	E	+ 5·10
			4. 55	E	+ 4·80				6. 0	W	+ 6·85
			6. 5	E	+ 4·90				6. 25	W	+ 5·75
			6. 25	E	+ 5·20						
							12	P	5. 10	E	+ 4·25
	6	P	4. 15	W	+ 5·80				5. 45	E	+ 3·80
			4. 45	W	+ 5·30				6. 5	W	+ 3·90
			6. 5	E	+ 5·75				6. 30	W	+ 3·70
	9	C	5. 55	E	+ 7·90		13	P	5. 25	E	+ 4·70
			6. 20	E	+ 8·40				5. 45	E	+ 4·30
			6. 50	E	+ 6·80				6. 5	W	+ 4·25
			7. 15	W	+ 8·45				6. 25	W	+ 4·20

TABLE III.—AZIMUTH ERROR of the TRANSIT INSTRUMENT at BURNHAM, and OBSERVATIONS of the MERIDIAN MARK.

[The sign + indicates that the Optic Axis points East of North.]

Day.		Approx. Local Mean Time.	Observer.	Objects observed. M. M. = Meridian Mark.		Apparent Error of Azimuth.	Remarks.
1874.		h m				″	
October	20	12. 30	P	z Octantis S.P. and α Arietis		− 0·6	
	21	9. 8	D	τ Octantis	ν Piscium	− 14·0	
		10. 9	D	o Octantis	ω Piscium	− 8·8	
	22	8. 3	C	c Octantis	ε Pegasi...........	− 9·0	
		9. 5	C	τ Octantis	ζ Pegasi...........	− 9·2	
	23	8. 0	P	c Octantis	ζ Pegasi...........	− 15·6	
		9. 1	P	τ Octantis	ω Piscium	− 13·0	
	26	11. 10	P	M. M. E. 20r·373, W. 19r·679		...	
		12. 10	P	z Octantis S.P.	ξ^1 Ceti	− 16·2	

Table III.—Azimuth Error of the Transit Instrument, &c.—*continued.*

Day.		Approx. Local Mean Time.	Observer.	Objects observed. M. M. = Meridian Mark.	Apparent Error of Azimuth.	Remarks.
1874.		h m			″	
October	28*	15. 43	C	σ Octantis and ι Geminorum	+ 33·1	
		...	C	M. M. E. 19·369, W. 20·653	...	M. M. shifted 3·5 inches to East before this observation.
	30	9. 36	D	τ Octantis ... ω Piscium	+ 35·6	
		...	D	M. M. E. 19·374, W. 20·696	...	
		9. 56	D	Brisbane 4091 S.P. ... τ Octantis	+ 33·4	
November	1	8. 30	P	M. M. E. 19·336, W. 20·749	+ 35·0	
		9. 0	P	M. M. E. 19·345, W. 20·746		
		10. 0	P	M. M. E. 19·353, W. 20·758		
	2	Afternoon	D	M. M. E. 19·647, W. 20·450	...	
		Night	D	M. M. E. 19·981	...	Nov. 2, 5ʰ, L.M.T. The level and azimuth were adjusted.
		9. 32	D	ο Octantis ... Brisbane 4091 S.P.	+ 1·6	
	3	Night	C	M. M. E. 19·869, W. 20·183	...	
		9. 22	C	ο Octantis ... α Andromedæ	+ 1·6	
	4	11. 40	P	z Octantis S.P. ... α Arietis	+ 9·0	Azimuth Error adopted + 9″·6.
		Night	P	M. M. E. 19·838, W. 20·286	...	
			P	M. M. E. 19·820, W. 20·284	...	
	6	8. 4	C	τ Octantis ... ω Piscium	+ 4·6	
		9. 10	C	ο Octantis ... α Andromedæ	+ 1·9	
	7	9. 15	D	ο Octantis ... Brisbane 4091 S.P.	+ 8·2	
		Night	D	M. M. E. 19·796, W. 20·201	...	
	8	9. 15	P	ο Octantis ... Brisbane 4091 S.P.	+ 15·2	
		9. 40	P	M. M. E. 19·735, W. 20·333	...	
	9	9. 15	C	Brisbane 4091 S.P. ... α Andromedæ	+ 23·9	
		Night	C	M. M. E. 19·629, W. 20·464	...	
	10	3. 11	P	M. M. E. 19·475, W. 20·575	...	
		3. 21	P	M. M. E. 19·497, W. 20·568	...	
	11	11. 6	P	z Octantis S.P. ... δ Arietis	+ 22·7	
		11. 26	P	M. M. E. 19·275, W. 20·543	...	M. M. very unsteady.
	12	9. 4	C	Brisbane 4091 S.P. ... ε Piscium	+ 28·6	
		...	C	M. M. E. 19·322, W. 20·688	...	
		11. 2	C	z Octantis S.P. ... Brisbane 4091 S.P.	+ 31·2	
	15	8. 40	P	ο Octantis ... Brisbane 4091 S.P.	+ 41·2	
		10. 5	P	M. M. E. 19·256, W. 20·779	...	

* There is no record between these dates of the azimuth adjustment having been altered.

Table III.—Azimuth Error of the Transit Instrument, &c.—*continued.*

Day.	Approx. Local Mean Time.	Observer.	Objects observed. M. M. = Meridian Mark.	Apparent Error of Azimuth.	Remarks.
1874.	h m			″	
November 18	8. 35	D	o Octantis and Brisbane 4091 S.P.	+ 43·6	
	Night	D	M. M. E. 19·131, W. 20·890............	...	
20	7. 15	P	M. M. E. 19·865, W. 20·156............	...	
	8. 25	P	o Octantis .... Brisbane 4091 S.P. .	+ 1·2	
21	8. 21	P	o Octantis .... Brisbane 4091 S.P. .	+ 1·4	
	8. 47	P	M. M. E. 19·876, W. 20·124............	...	
23	...	P	M. M. E. 19·955, W. 20·096............	...	M. M. unsteady.
	10. 20	P	z Octantis S.P. .... 67 Ceti	− 0·5	
25	8. 5	D	o Octantis .... Brisbane 4091 S.P. .	+ 13·5	
27	8. 11	D	Brisbane 4091 S.P.... ε Piscium	+ 7·8	
	Night	D	M. M. E. 19·741, W. 20·295............	+ 11·1	
	10. 8	D	z Octantis S.P. .... ν Piscium	+ 14·2	
28	8. 2	P	Brisbane 4091 S.P.... ε Piscium	+ 18·9	Adopted + 12″·9.
	Night	P	M. M. E. 19·716, W. 20·316............	+ 12·9	
29	7. 58	D	Brisbane 4091 S.P.... β Hydri	+ 8·7	Adopted + 11″·15.
	Night	D	M. M. E. 19·743, W. 20·308............	...	
	9. 56	D	z Octantis S.P. .... α Eridani	+ 13·6	
30	7. 54	P	Brisbane 4091 S.P.... ζ¹ Piscium	+ 11·8	Adopted + 12″·3.
	...	P	M. M. E. 19·736, W. 20·335............	...	
	...	P	M. M. E. 19·742, W. 20·327............	...	
	9. 51	P	z Octantis S.P. .... o Piscium	+ 12·8	
December 1	7. 50	P	Brisbane 4091 S.P. ... ζ¹ Piscium	+ 13·0	
	...	P	M. M. E. 19·713, W. 20·337............	...	
	9. 47	P	z Octantis S.P. .... γ² Ceti	+ 12·8	
2	9. 44	P	z Octantis S.P. .... γ² Ceti	+ 11·8	
	...	P	M. M. E. 19·777, W. 20·309............	...	
3	9. 39	P	z Octantis S.P. .... 67 Ceti	+ 13·4	
	...	P	M. M. E. 19·771, W. 20·316............	...	
4	...	P	M. M. E. 19·745, W. 20·329............	...	
5	9. 52	P	M. M. E. 19·700, W. 20·418............	...	
	10. 2	P	M. M. E. 19·670, W. 20·416............	+ 16·4	
6	...	D	M. M. E. 19·636, W. 20·444............	+ 18·1	
	13. 10	D	σ Octantis .... 1 Geminorum.....	+ 17·9	

Table III.—Azimuth Error of the Transit Instrument, &c.—*continued.*

Day.	Approx. Local Mean Time.	Observer.	Objects observed. M. M. = Meridian Mark.	Apparent Error of Azimuth.	Remarks.
1874.	h m			″	
December 8	10. 30	D	M. M. E. 19·633, W. 20·468.............	+ 18·8	
9	9. 36	P	M. M. E. 19·637, W. 20·471.............	...	
10	9. 20	D	z Octantis and α Ceti......................	+ 16·9	
	...	D	M. M. E. 19·591, W. 20·516.............	...	
18	8. 39	C	z Octantis .... α Arietis	− 0·7	
	...	C	M. M. E. 19·951, W. 20·104.............	...	
19	7. 27	D	M. M. E. 19·918, W. 20·101.............	...	
	10. 7	D	M. M. E. 19·935, W. 20·078.............	...	
	12. 20	D	σ Octantis .... κ Orionis..........	− 0·2	
20	8. 31	C	z Octantis .... f Tauri............	− 8·4	
26	13. 51	D	A Octantis .... Procyon...........	− 10·9	
	14. 19	D	M. M. E. 20·157, W. 19·939.............	− 11·0	
27	11. 48	C	σ Octantis .... ξ Geminorum	− 1·4	
	...	C	M. M. E. 20·127, W. 19·936.............	...	
28	...	D	M. M. E. 20·100, W. 19·913.............	...	
	11. 44	D	σ Octantis .... α Orionis..........	− 9·7	
29	11. 40	P	σ Octantis .... ν Orionis..........	− 15·4	
31	...	P	M. M. E. 20·239, W. 19·744.............	...	
1875.					
January 5	9. 45	P	M. M. E. 20·017, W. 19·965.............	...	
	...	P	M. M. E. 19·988, W. 20·018.............	...	
	11. 13	P	σ Octantis .... ν Orionis	− 4·1	
	11. 30	P	M. M. E. 19·996	...	
6	8. 56	P	M. M. E. 20·003, W. 20·022.............	...	
	...	P	M. M. E. 19·987, W. 19·984.............	− 4·6	
9	11. 0	C	σ Octantis .... ν Geminorum	− 9·0	
	...	C	M. M. E. 20·088, W. 19·887.............	...	
11	9. 36	P	M. M. E. 20·064, W. 19·933.............	...	
	10. 49	P	σ Octantis .... α Orionis..........	− 10·9	
	11. 6	P	M. M. E. 20·043, W. 19·965.............	...	

Table III.—Azimuth Error of the Transit Instrument, &c.—*continued.*

Day.	Approx. Local Mean Time.	Observer.	Objects observed. M. M. = Meridian Mark.	Apparent Error of Azimuth.	Remarks.
1875.	h m			″	
January 12	9. 32	P	M. M. E. 20·071, W. 19·941	...	
	10. 47	P	σ Octantis .... ν Orionis	− 7·0	
	11. 2	P	M. M. E. 20·057, W. 19·994	...	
13	9. 28	P	M. M. E. 20·074, W. 19·930	...	
	10. 43	P	σ Octantis .... ν Orionis	− 7·9	
	10. 58	P	M. M. E. 20·068, W. 19·934	...	

ABSTRACT of TABLES IV. and V.—TRANSITS of STARS and of the MOON, and Inferred R.A. of the MOON'S LIMB at TRANSIT.

Day, 1874.	Observer.	Position of Micrometer Head.	Number of Transits of Clock Stars.	Number of Transits of Circumpolar Stars.	Mean Sidereal Time of Transits of Clock Stars.	Clock Slow on Local Sidereal Time.	Clock's Losing Rate.	Limb of Moon observed.	Clock Time of Transit of Moon's Limb over Meridian.	Right Ascension of Moon's Limb on Meridian.
					h m	s	s		h m s	h m s
Oct. 20	C	W.	4		1. 42	+ 7·55				
	P	E.	4	1						
	P	W.		1						
21	D	W.	7	2	23. 4	+ 13·76	+ 6·97	I.	22. 25. 38·10	22. 25. 51·65
	D	E.	[illegible]	1						
22	C	E.	5	2	23. 7	+ 21·61	+ 7·83	I.	23. 20. 11·46	23. 20. 33·10
	C	W.	5	1						
23	P	W.	3	2	23. 34	+ 8·40		I.	0. 14. 54·55	0. 15. 3·02
	P	E.	5	1						
26	P	W.	8	1	2. 54	+ 23·84	+ 4·92	II.	3. 11. 36·44	3. 12. 0·34
28	C	E.	6		5. 10	+ 32·68	+ 4·22	II.	5. 22. 54·27	5. 23. 26·94
	C	W.	5	1						
30	D	W.	2	1	0. 8	+ 41·15	+ 4·72			
	D	E.	4	1						

Abstract of Tables IV. and V.—Transits of the Stars and of the Moon, &c.—*continued.*

Day, 1874.	Observer.	Position of Micrometer Head.	Number of Transits of Clock Stars.	Number of Transits of Circumpolar Stars.	Mean Sidereal Time of Transits of Clock Stars.	Clock Slow on Local Sidereal Time.	Clock's Losing Rate.	Limb of Moon observed.	Clock Time of Transit of Moon's Limb over Meridian.	Right Ascension of Moon's Limb on Meridian.
					h m	s	s		h m s	h m s
Nov. 1	P	E.	1		0. 2	+ 2·83				
2	D	E.	3	2	0. 30	+ 3·36	+ 0·52			
	D	W.	3							
3	C	E.	3		0. 47	+ 5·23	+ 1·85			
	C	W.	3							
4	P	W.	4		1. 45	+ 6·10	+ 0·84			
	P	E.	2	1						
6	C	W.	3		0. 21	+ 9·03	+ 1·51			
	[illegible]	E.	3							
7	D	E.	4	2	0. 30	+ 11·57	+ 2·52			
8	P	W.	4		0. 5	+ 14·36	+ 2·84			
	P	E.	4	2						
9	C	E.	2		0. 36	+ 16·32	+ 1·92			
	C	W.	[illegible]							
11	P	W.	3	1	3. 23	+ 21·48				
	P	E.	4							
12	C	W.	4	1	1. 28	+ 20·17	− 1·42			
	C	E.	4	1						
15	P	E.	4	2	1. 13	+ 16·89	− 1·10			
	P	W.	4							
18	D	W.	6	2	23. 57	+ 11·81	− 1·71	I.	22. 56. 25·98	22. 56. 37·84
	D	E.	2							
20	P	E.	4		0. 24	+ 0·06		I.	0. 42. 4·30	0. 42. 4·53
	P	W.	5	2						
21	P	W.		2						
23	P	E.	5	1	2. 56	+ 3·63	+ 1·15	I.	3. 38. 15·97	3. 38. 19·65
	P	W.	3							
25	D	E.	10	2	3. 56	+ 8·57	+ 2·42	I.	5. 56. 10·82	5. 56. 19·62
	D	W.	3							

Abstract of Tables IV. and V.—Transits of Stars and of the Moon, &c.—*continued.*

Day, 1874.	Observer.	Position of Micrometer Head.	Number of Transits of Clock Stars.	Number of Transits of Circumpolar Stars.	Mean Sidereal Time of Transits of Clock Stars.	Clock Slow on Local Sidereal Time.	Clock's Losing Rate.	Limb of Moon observed.	Clock Time of Transit of Moon's Limb over Meridian.	Right Ascension of Moon's Limb on Meridian.
					h m	s	s		h m s	h m s
Nov. 27	D	W.	4	1	3. 30	+14·20	+ 2·84	II.	8. 7. 29·15	8. 7. 43·82
	D	E.	5	1						
28	P	E.	4	1	1. 25	+16·07	+ 2·05			
	P	W.	2							
29	D	W.	3	2	1. 21	+17·18	+ 1·11			
	D	E.	2	1						
30	P	W.	3	2	1. 33	+18·88	+ 1·69			
	P	E.	4							
Dec. 1	P	W.	3	2	1. 42	+19·77	+ 0·88			
	P	E.	3							
2	P	E.	3	1	3. 27	+20·48	+ 0·66			
	P	W.	4							
3	P	E.	3	1	2. 31	+21·60	+ 1·16			
5	P	E.	5		3. 40	+23·42	+ 0·89			
	P	W.	3							
6	D	W.	3		5. 23	+24·33	+ 0·85			
	D	E.	3	1						
8	D	W.	4		6. 20	+25·61	+ 0·63			
9	P	E.		1						
10	D	W.	2	1	2. 46	+25·75	+ 0·08			
	D	E.	2							
18	C	W.	3		2. 30	+13·37	(− 1·55)			
	C	E.	3							
19	D	E.	6		3. 20	+10·70	− 2·58	I.	2. 7. 50·42	2. 8. 1·39
	D	W.	3	1						
20	C	W.	4		4. 4	+ 8·62	− 2·02			
	C	E.	4							
26	D	W.	4		5. 22	− 3·50	− 2·00			
	D	E.	3	1						

Abstract of Tables IV. and V.—Transits of Stars and of the Moon, &c.—*continued.*

Day, 1874.	Observer.	Position of Micrometer Head.	Number of Transits of Clock Stars.	Number of Transits of Circumpolar Stars.	Mean Sidereal Time of Transits of Clock Stars.	Clock Slow on Local Sidereal Time.	Clock's Losing Rate.	Limb of Moon observed.	Clock Time of Transit of Moon's Limb over Meridian.	Right Ascension of Moon's Limb on Meridian.
					h m	s	s		h m s	h m s
Dec. 27	C	E.	3		7. 4	− 3·50	0·00			
	C	W.	3							
28	D	W.	3		4. 12	− 3·25	+ 0·28			
	D	E.	6	1						
29	P	E.	3		5. 4	− 2·88	+ 0·36			
	P	W.	4	1						
1875.										
Jan. 5	P	W.	3		5. 12	+ 2·21	+ 0·73			
	P	E.	3	1						
6	P	W.	3		5. 3	+ 3·55	+ 1·35			
	P	E.	2							
9	C	E.	3	1	6. 56	+ 8·63	+ 1·64			
	C	W.	3							
11	P	E.	3		5. 48	+ 10·85	+ 1·14			
	P	W.	3	1						
12	P	E.	3		5. 48	+ 10·82	− 0·03			
	P	W.	3	1						
13	P	E.	3		5. 45	+ 11·12	+ 0·30			
	P	W.	3	1						

TABLE VI.—LONGITUDE of BURNHAM, N. Z., from the observed R.A. of the MOON on the MERIDIAN.

Day.	Observer.	Moon's Limb.	Observed R.A. of the Moon's Limb on the Meridian.	Longitude by the Ephemeris. ϵ = the Correction required to the Moon's Tabular R.A.	Adopted Value of ϵ.	Resulting Longitude East of Greenwich.
1874.			h m s	h m s	s	h m s
October 21	D	I.	22. 25. 51·65	11. 29. 22·20 + 26·09 ϵ	− 0·48	11. 29. 9·7
22	C	I.	23. 20. 33·10	11. 29. 25·38 + 26·43 ϵ	− 0·54	11. 29. 11·1
23	P	I.	0. 15. 3·02	11. 29. 23·95 + 26·32 ϵ	− 0·63	11. 29. 7·4
26	P	II.	3. 12. 0·34	11. 29. 29·43 + 22·81 ϵ	− 0·86:	11. 29. 9·8
28	C	II.	5. 23. 26·94	11. 29. 34·20 + 20·98 ϵ	− 0·88	11. 29. 15·7
November 18	D	I.	22. 56. 37·84	11. 29. 24·38 + 27·40 ϵ	− 0·38	11. 29. 14·0
20	P	I.	0. 42. 4·53	11. 29. 18·21 + 26·79 ϵ	− 0·49	11. 29. 5·1
23	P	I.	3. 38. 19·65	11. 29. 21·92 + 38·08 ϵ	− 0·75	11. 29. 5·3
25	D	II.	5. 56. 19·62	11. 29. 32·52 + 20·98 ϵ	− 0·83	11. 29. 15·1
27	D	II.	8. 7. 43·82	11. 29. 36·24 + 23·53 ϵ	− 0·82	11. 29. 17·0
December 19	D	I.	2. 8. 1·19	11. 29. 26·33 + 25·32 ϵ	− 0·53	11. 29. 12·9

The Mean Resulting Longitude from 7 transits of the First Limb is. ...... h m s 11. 29. 9·4
That from 4 transits of the Second Limb is.......................... 11. 29. 11·9

General Mean ..... 11. 29. 10·6

TABLE VII.—LONGITUDE of BURNHAM, from the observed AZIMUTHS of the MOON.

Moon I.				Moon II.			
Day.	Observer.	Number of Observations.	Mean Inferred Longitude for Day (East).	Day.	Observer.	Number of Observations.	Mean Inferred Longitude for Day (East).
1874.			h m s	1874.			h m s
October 23	D	4	11. 29. 11·1	October 26	C	4	11. 29. 20·9
December 18	P	8	11. 29. 27·7	28	D	4	11. 29. 23·4
19	C	6	11. 29. 29·3	December 27	D	4	11. 29. 16·5
20	D	6	11. 29. 12·2	28	C	6	11. 29. 14·8
				29	D	6	11. 29. 29·0
Mean.......... 11. 29. 20·1				Mean.......... 11. 29. 20·9			

Mean Longitude East, by observed Azimuths............. h m s 11. 29. 20·5

TRANSIT OF VENUS, 1874.

APPENDIX.

APPENDIX.

Appendix I.—Extract from Instructions to Observers.

(Instructions were prepared in considerable detail for all the circumstances in which they appeared necessary, but I confine myself in the following extract to the two paragraphs which applied to the actual observation.)

Section (X.), Article 11 :—

" The record of observation will be made thus :

" For a micrometer-observation, the observer will give the word 'now' or other sudden signal, for time ; the assistant at the clock will enter the time ; the observer will give the micrometer-reading, and the assistant will write down the micrometer-reading.

" For the observation of internal contact, where two or three phænomena may present themselves at intervals of time too small to admit of writing at length, the observer will simply give 'now' for a time to be recorded, and at next phænomenon will simply give 'now,' the time of which is to be recorded in the book, leaving a gap of several lines ; and so on, as often as may be necessary. When the pressure of phænomena ceases, the observer is to give from memory the details of the phænomenon to which each time-entry applies, and the assistant is to enter them in their proper places."

Appendix II.—Corrections to the Tabular Right Ascension of the Moon.

(Major Tupman examined most carefully all the observations of the Moon made at the principal Observatories of Europe, through the time included in the observations connected with the Transit of Venus, and exhibited in a graphical form in the Monthly Notice of the Royal Astronomical Society for March 1877, vol. 37, page 256, the corrections to the R.A. and N.P.D. of the Moon printed in the Nautical Almanac. The corrections to R.A. are measured from Major Tupman's curves, and are exhibited numerically in the following table. They have been used in the reductions throughout by Major Tupman.)

Day.	Correction to R. A. of N. A.	Day.	Correction to R. A. of N. A.	Day.	Correction to R. A. of N. A.	Day.	Correction to R. A. of N. A.
1874.	s	1874.	s	1874.	s	1874.	s
Sept. 14	− 0·37	Sept. 18	− 0·44	Sept. 22	− 0·49	Sept. 26	− 0·70
15	− 0·39	19	− 0·45	23	− 0·53	27	− 0·78
16	− 0·42	20	− 0·46	24	− 0·58	28	− 0·83
17	− 0·43	21	− 0·47	25	− 0·64	29	− 0·84

Day.	Correction to R. A. of N. A.
1874.	s
Sept. 30	− 0·81
Oct. 1	− 0·76
2	− 0·72
3	− 0·66
4	− 0·63
5	− 0·58
6	− 0·55
7	− 0·53
12	− 0·26
13	− 0·27
14	− 0·28
15	− 0·31
16	− 0·34
17	− 0·37
18	− 0·40
19	− 0·44
20	− 0·47
21	− 0·50
22	− 0·54
23	− 0·59
24	− 0·66
25	− 0·75
26	− 0·79
27	− 0·80
28	− 0·78
29	− 0·76
30	− 0·73
31	− 0·70
Nov. 1	− 0·66
2	− 0·64
3	− 0·59

Day.	Correction to R. A. of N. A.
1874.	s
Nov. 4	− 0·55
5	− 0·52
6	− 0·47
12	− 0·43
13	− 0·42
14	− 0·40
15	− 0·37
16	− 0·34
17	− 0·32
18	− 0·34
19	− 0·38
20	− 0·44
21	− 0·51
22	− 0·59
23	− 0·68
24	− 0·76
25	− 0·85
26	− 0·93
27	− 0·90
28	− 0·80
29	− 0·67
30	− 0·60
Dec. 1	− 0·55
2	− 0·53
3	− 0·51
4	− 0·50
5	− 0·49
12	− 0·34
13	− 0·34
14	− 0·35
15	− 0·36
16	− 0·40

Day.	Correction to R. A. of N. A.
1874.	s
Dec. 17	− 0·44
18	− 0·46
19	− 0·50
20	− 0·55
21	− 0·59
22	− 0·64
23	− 0·68
24	− 0·74
25	− 0·75
26	− 0·76
27	− 0·74
28	− 0·66
29	− 0·60
30	− 0·54
31	− 0·50
1875.	
Jan. 1	− 0·46
2	− 0·44
3	− 0·43
10	− 0·41
11	− 0·41
12	− 0·42
13	− 0·43
14	− 0·45
15	− 0·46
16	− 0·48
17	− 0·50
18	− 0·54
19	− 0·56
20	− 0·58
21	− 0·62
22	− 0·65

Day.	Correction to R. A. of N. A.
1875.	s
Jan. 23	− 0·66
24	− 0·66
25	− 0·65
26	− 0·62
27	− 0·57
28	− 0·52
29	− 0·46
30	− 0·43
31	− 0·39
Feb. 1	− 0·37
7	− 0·29
8	− 0·30
9	− 0·33
10	− 0·35
11	− 0·38
12	− 0·41
13	− 0·45
14	− 0·51
15	− 0·55
16	− 0·58
17	− 0·60
18	− 0·58
19	− 0·55
20	− 0·53
21	− 0·47
22	− 0·44
23	− 0·41
24	− 0·38
25	− 0·36
26	− 0·35
27	− 0·34

APPENDIX III.—GEOCENTRIC ELEMENTS of the POSITIONS of the SUN and VENUS for times near to those of the INGRESS and EGRESS of VENUS at the SUN'S LIMB, formed by INTERPOLATION between the PLACES in the NAUTICAL ALMANAC.

Greenwich Sidereal Time on Dec. 8.	R. A. of Sun.	N. P. D. of Sun.	R. A. of Venus.	N. P. D. of Venus.	Greenwich Sidereal Time on Dec. 8.	R. A. of Sun.	N. P. D. of Sun.	R. A. of Venus.	N. P. D. of Venus.
	° ′ ″	° ′ ″	° ′ ″	° ′ ″		° ′ ″	° ′ ″	° ′ ″	° ′ ″
h m					h m				
	255. 43.	112. 48.	255. 57.	112. 37.		255. 44.	112. 48.	255. 57.	112. 37.
6. 50	43·30	32·35	64·07	46·22	7. 15	51·73	38·57	25·00	26·42
51	46·03	32·60	62·51	45·43	16	54·47	38·82	23·43	25·63
52	48·77	32·85	60·94	44·63	17	57·21	39·07	21·87	24·84
53	51·51	33·10	59·38	43·84	18	59·94	39·31	20·31	24·04
54	54·25	33·35	57·82	43·05	19	62·68	39·56	18·74	23·25
	255. 43.	112. 48.	255. 57.	112. 37.		255. 45.	112. 48.	255. 57.	112. 37.
6. 55	56·98	33·60	56·26	42·26	7. 20	5·42	39·81	17·18	22·46
56	59·72	33·85	54·69	41·47	21	8·16	40·06	15·62	21·67
57	62·46	34·09	53·13	40·68	22	10·90	40·31	14·06	20·88
58	65·20	34·34	51·57	39·88	23	13·63	40·56	12·49	20·08
59	67·93	34·59	50·00	39·09	24	16·37	40·81	10·93	19·29
	255. 44.	112. 48.	255. 57.	112. 37.		255. 45.	112. 48.	255. 57.	112. 37.
7. 0	10·67	34·84	48·44	38·30	7. 25	19·11	41·05	9·37	18·50
1	13·41	35·09	46·88	37·51	26	21·84	41·30	7·80	17·71
2	16·15	35·34	45·32	36·72	27	24·58	41·55	6·24	16·91
3	18·88	35·59	43·75	35·92	28	27·32	41·80	4·68	16·12
4	21·62	35·83	42·19	35·13	29	30·06	42·05	3·11	15·33
	255. 44.	112. 48.	255. 57.	112. 37.		255. 45.	112. 48.	255. 56.	112. 37.
7. 5	24·36	36·08	40·63	34·34	7. 30	32·79	42·30	61·55	14·54
6	27·10	36·33	39·06	33·55	31	35·53	42·55	59·99	13·74
7	29·83	36·58	37·50	32·76	32	38·27	42·79	58·43	12·95
8	32·57	36·83	35·94	31·96	33	41·00	43·04	56·86	12·16
9	35·31	37·08	34·37	31·17	34	43·74	43·29	55·30	11·37
	255. 44.	112. 48.	255. 57.	112. 37.		255. 45.	112. 48.	255. 56.	112. 37.
7. 10	38·05	37·33	32·81	30·38	7. 35	46·48	43·54	53·74	10·57
11	40·78	37·57	31·25	29·59	36	49·22	43·79	52·17	9·78
12	43·52	37·82	29·69	28·80	37	51·95	44·03	50·61	8·99
13	46·26	38·07	28·12	28·00	38	54·69	44·28	49·05	8·20
14	48·99	38·32	26·56	27·21	39	57·43	44·53	47·48	7·40
	Semi-diameter of Sun.	Parallax of Sun.	Semi-diameter of Venus.	Parallax of Venus.		Semi-diameter of Sun.	Parallax of Sun.	Semi-diameter of Venus.	Parallax of Venus.
	16′. 16″·80	9″·09	31″·42	33″·86		16′. 16″·80	9″·09	31″·42	33″·86

Greenwich Sidereal Time on Dec. 8.	R. A. of Sun.	N. P. D. of Sun.	R. A. of Venus.	N. P. D. of Venus.	Greenwich Sidereal Time on Dec. 8.	R. A. of Sun.	N. P. D. of Sun.	R. A. of Venus.	N. P. D. of Venus.
	° ′ ″	° ′ ″	° ′ ″	° ′ ″		° ′ ″	° ′ ″	° ′ ″	° ′ ″
h m					h m				
	255. 46.	112. 48.	255. 56.	112. 37.		255. 46.	112. 48.	255. 56.	112. 36.
7. 40	0·16	44·78	45·92	6·61	7. 45	13·85	46·02	38·11	62·65
41	2·90	45·03	44·36	5·82	46	16·59	46·27	36·55	61·86
42	5·64	45·28	42·80	5·03	47	19·32	46·52	34·98	61·06
43	8·38	45·52	41·23	4·23	48	22·06	46·76	33·42	60·27
44	11·11	45·77	39·67	3·44	49	24·80	47·01	31·86	59·48
						255. 46.	112. 48.	255. 56.	112. 36.
					7. 50	27·54	47·26	30·29	58·69
	Semi-diameter of Sun.	Parallax of Sun.	Semi-diameter of Venus.	Parallax of Venus.		Semi-diameter of Sun.	Parallax of Sun.	Semi-diameter of Venus.	Parallax of Venus.
	16′. 16″·80	9″·09	31″·42	33″·86		16′. 16″·80	9″·09	31″·42	33″·86

	255. 46.	112. 48.	255. 56.	112. 36.
8. 0	54·91	49·74	14·67	50·76
	255. 47.		255. 55.	
8. 10	22·28	52·22	59·04	42·83
8. 20	49·66	54·70	43·42	34·91
	255. 48.			
8. 30	17·03	57·18	27·79	26·98
8. 40	44·40	59·65	12·17	19·05
	255. 49.	112. 49.	255. 54.	
8. 50	11·78	2·13	56·54	11·13
9. 0	39·15	4·60	40·92	3·20
	255. 50.			112. 35.
9. 10	6·52	7·07	25·30	55·27
	Semi-diameter of Sun.	Parallax of Sun.	Semi-diameter of Venus.	Parallax of Venus.
	16′. 16″·81	9″·09	31″·42	33″·86

	255. 50.	112. 49.	255. 54.	112. 35.
9. 20	33·90	9·54	9·68	47·34
	255. 51.		255. 53.	
9. 30	1·28	12·01	54·05	39·42
9. 40	28·65	14·48	38·43	31·49
9. 50	56·03	16·94	22·80	23·56
	255. 52.			
10. 0	23·41	19·41	7·18	15·63
			255. 52.	
10. 10	50·78	21·87	51·56	7·70
	255. 53.			112. 34.
10. 20	18·16	24·34	35·94	59·77
10. 30	45·54	26·80	20·32	51·84
	Semi-diameter of Sun.	Parallax of Sun.	Semi-diameter of Venus.	Parallax of Venus.
	16′. 16″·81	9″·09	31″·42	33″·86

Greenwich Sidereal Time on Dec. 8.	R. A. of Sun.	N. P. D. of Sun.	R. A. of Venus.	N. P. D. of Venus.	Greenwich Sidereal Time on Dec. 8.	R. A. of Sun.	N. P. D. of Sun.	R. A. of Venus.	N. P. D. of Venus.
	° ′ ″	° ′ ″	° ′ ″	° ′ ″		° ′ ″	° ′ ″	° ′ ″	° ′ ″
h m	255. 53.	112. 49.	255. 52.	112. 34.	h m	255. 55.	112. 49.	225. 51.	112. 34.
10. 30	45·54	26·80	20·32	51·84	11. 0	7·68	34·17	33·46	28·05
31	48·28	27·04	18·76	51·05	1	10·42	34·42	31·90	27·26
32	51·02	27·29	17·19	50·26	2	13·16	34·66	30·33	26·46
33	53·75	27·53	15·63	49·46	3	15·89	34·91	28·77	25·67
34	56·49	27·78	14·07	48·67	4	18·63	35·15	27·21	24·88
	255. 53.	112. 49.	255. 52.	112. 34.		255. 55.	112. 49.	255. 51.	112. 34.
10. 35	59·23	28·02	12·51	47·88	11. 5	21·37	35·40	25·65	24·08
36	61·97	28·27	10·95	47·08	6	24·11	35·64	24·09	23·29
37	64·71	28·52	9·38	46·29	7	26·85	35·89	22·52	22·50
38	67·44	28·76	7·82	45·50	8	29·58	36·13	20·96	21·70
39	70·18	29·01	6·26	44·71	9	32·32	36·38	19·40	20·91
	255. 54.	112. 49.	255. 51.	112. 34.		255. 55.	112. 49.	255. 51.	112. 34.
10. 40	12·92	29·25	64·70	43·91	11. 10	35·06	36·63	17·84	20·12
41	15·66	29·50	63·14	43·12	11	37·80	36·87	16·28	19·32
42	18·40	29·75	61·57	42·33	12	40·54	37·12	14·71	18·53
43	21·13	29·99	60·01	41·53	13	43·27	37·36	13·15	17·74
44	23·87	30·24	58·45	40·74	14	46·01	37·61	11·59	16·95
	255. 54.	112. 49.	255. 51.	112. 34.		255. 55.	112. 49.	255. 51.	112. 34.
10. 45	26·61	30·48	56·89	39·95	11. 15	48·75	37·85	10·03	16·15
46	29·35	30·73	55·33	39·15	16	51·49	38·10	8·47	15·36
47	32·09	30·97	53·76	38·36	17	54·23	38·34	6·90	14·57
48	34·82	31·22	52·20	37·57	18	56·96	38·59	5·34	13·77
49	37·56	31·47	50·64	36·78	19	59·70	38·84	3·78	12·98
	255. 54.	112. 49.	255. 51.	112. 34.		255. 56.	112. 49.	255. 50.	112. 34.
10. 50	40·30	31·71	49·08	35·98	11. 20	2·44	39·08	62·22	12·19
51	43·04	31·96	47·52	35·19	21	5·18	39·33	60·66	11·39
52	45·78	32·20	45·95	34·40	22	7·92	39·57	59·09	10·60
53	48·51	32·45	44·39	33·60	23	10·65	39·82	57·53	9·81
54	51·25	32·70	42·83	32·81	24	13·39	40·06	55·97	9·01
	255. 54.	112. 49.	255. 51.	112. 34.		255. 56.	112. 49.	255. 50.	112. 34.
10. 55	53·99	32·94	41·27	32·02	11. 25	16·13	40·31	54·41	8·22
56	56·73	33·19	39·71	31·22	26	18·87	40·55	52·85	7·43
57	59·47	33·43	38·14	30·43	27	21·61	40·80	51·28	6·63
58	62·20	33·68	36·58	29·64	28	24·34	41·04	49·72	5·84
59	64·94	33·92	35·02	28·84	29	27·08	41·29	48·16	5·05
	Semi-diameter of Sun.	Parallax of Sun.	Semi-diameter of Venus.	Parallax of Venus.		Semi-diameter of Sun.	Parallax of Sun.	Semi-diameter of Venus.	Parallax of Venus.
	16′. 16″·82	9″·09	31″·42	33″·86		16′. 16″·82	9″·09	31″·42	33″·86

Greenwich Sidereal Time on Dec. 8.	R. A. of Sun.	N. P. D. of Sun.	R. A. of Venus.	N. P. D. of Venus.	Greenwich Sidereal Time on Dec. 8.	R. A. of Sun.	N. P. D. of Sun.	R. A. of Venus.	N. P. D. of Venus.
	° ′ ″	° ′ ″	° ′ ″	° ′ ″		° ′ ″	° ′ ″	° ′ ″	° ′ ″
h m	255. 56.	112. 49.	255. 50.	112. 34.	h m	255. 56.	112. 49.	255. 50.	112. 33.
11. 30	29·82	41·53	46·60	4·25	11. 40	57·20	43·98	30·98	56·32
31	32·56	41·78	45·04	3·46	41	59·94	44·23	29·42	55·53
32	35·30	42·02	43·48	2·67	42	62·68	44·47	27·86	54·74
33	38·03	42·27	41·91	1·87	43	65·41	44·72	26·30	53·94
34	40·77	42·51	40·35	1·08	44	68·15	44·96	24·73	53·15
	255. 56.	112. 49.	255. 50.	112. 33.		255. 57.	112. 49.	255. 50.	112. 33.
11. 35	43·51	42·76	38·79	60·29	11. 45	10·89	45·21	23·17	52·36
36	46·25	43·00	37·23	59·49	46	13·63	45·45	21·61	51·56
37	48·99	43·25	35·67	58·70	47	16·37	45·70	20·05	50·77
38	51·72	43·49	34·10	57·91	48	19·10	45·94	18·49	49·98
39	54·46	43·74	32·54	57·12	49	21·84	46·19	16·93	49·18
						255. 57.	112. 49.	255. 50.	112. 33.
					11. 50	24·58	46·43	15·36	48·39
	Semi-diameter of Sun.	Parallax of Sun.	Semi-diameter of Venus.	Parallax of Venus.		Semi-diameter of Sun.	Parallax of Sun.	Semi-diameter of Venus.	Parallax of Venus.
	16′. 16″·82	9″·09	31″·42	33″·86		16′. 16″·82	9″·09	31″·42	33″·86

APPENDIX IV.—SPECIMENS of the SKELETON FORMS Nos. 17, 18, 19, 20, used in the COMPUTATION of the FACTORS in the FINAL EQUATION formed from each OBSERVATION of INGRESS or EGRESS.

[FORM No. 17.]

BRITISH EXPEDITION FOR THE OBSERVATION

Station Latitude Log. Normal-centric Radius

Local Ordinal No.	Observation.		Times.				Tabular R. A. of	
	Observer.	Phænomenon or Measure.	Name of Clock or Chrono-meter.	Time by Clock or Chrono-meter.	Local Sidereal Time.	Greenwich Sidereal Time.	Geoc. R. A. of ☉ of ♀ Excess for ♀.	Parallax in R. A. of ☉ of ♀ Exc. for ♀.
1	2	3	4	5	6	7	8	9

Each Chief of Station, or Observer, is requested to place his signature under the Columns of Observations and

[PAGE

OF THE TRANSIT OF VENUS, 1874.

Log. Axial Distance Assumed W. Longitude

Sun and Venus.		Tabular N. P. D. of Sun and Venus.				Tabular Local Distance of Centers.	
Local R. A. of ☉ of ♀ Excess for ♀.	Incr. of R. A. in 1^s of ☉ of ♀ Excess for ♀.	Geoc. N. P. D. of ☉ of ♀ Excess for ♀.	Parallax in N. P. D. of ☉ of ♀ Excess for ♀.	Local N. P. D. of ☉ of ♀ Excess for ♀.	Incr. of N. P. D. in 1^s of ☉ of ♀ Excess for ♀.	Local Distance given by Tabular Elements.	Incr. of Dist. in 1^s and for $\frac{1}{100}$ incre. of Parallax.
10	11	12	13	14	15	16	17

Times, and each Computer is requested to place his signature under the calculations for which he is responsible.

[FORM No. 18.] [PAGE

BRITISH EXPEDITION FOR OBSERVATION OF THE TRANSIT OF VENUS, 1874.

COMPUTATION OF NORMAL-CENTRIC ELEMENTS.

(The surface of a concentric sphere being supposed to touch the equator, and a line normal to the equatoreal plane being drawn through the observing station to the surface of the sphere ; its intersection with the surface of the sphere is the "corresponding point;" and the latitude, on the sphere, of that point is the "corresponding latitude."

The normal to the spheroidal surface at the observing station, being produced to intersection with the earth's axis, is the "Normal-centric radius;" the place of that intersection is the "Normal Center," always in the hemisphere opposite to the hemisphere of the station; the distance of that intersection from the Earth's Center, measured along the earth's axis, is the "Axial Distance of Normal Center.")

Station			
Astronomical Latitude	° ′ ″ . .	° ′ ″ . .	° ′ ″ . .
Log. tan. astronomical latitude .... Log. 299—Log. 300	, 9 , 9 9 8 5 5	, 9 , 9 9 8 5 5	, 9 , 9 9 8 5 5
Sum = log. tan. corresponding latitude	,	,	,
Corresponding Latitude	° ′ ″ . .	° ′ ″ . .	° ′ ″ . .
Log. cosine corresponding latitude .... Subtract log. cos. astronomical latitude	, ,	, ,	, ,
Log. Normal-centric Radius	,	,	,
Log. sine corresponding latitude .... Add ar. co. log. 150	, 7 , 8 2 3 9 1	, 7 , 8 2 3 9 1	, 7 , 8 2 3 9 1
Log. Axial Distance of Normal Center	,	,	,

NOTE.—Angles are to be taken to the nearest 10″.
Logarithms to 5 decimal places.

Computer's signature.

[FORM No. 19.] [PAGE

BRITISH EXPEDITION FOR OBSERVATION OF THE TRANSIT OF VENUS, 1874.

CALCULATION OF TABULAR PARALLAXES IN R.A. AND N.P.D. BY NORMAL-CENTRIC METHOD.

Station . Latitude N.S. ° ′ ″. Log. Normal-centric Radius ,

Log. Axial Dist. of Normal Center , . Tab. hor. eq. parallax, for ☉ ″, , for ♀ ″,

Obs. No. (17), E.W. of Merid.						
Object.	Sun.	Venus.	Sun.	Venus.	Sun.	Venus.
	h m s	h m s	h m s	h m s	h m s	h m s
Local Sidereal Time..........	. .	. .	. .	. .	. .	. .
Multiply by 60, divide by 4....	. .	. .	. .	. .	. .	. .
	° ′ ″	° ′ ″	° ′ ″	° ′ ″	° ′ ″	° ′ ″
R.A. of Zenith in arc.........	. .	. .	. .	. .	. .	. .
Tab. R.A. of object (17)......	. .	. .	. .	. .	. .	. .
Difference = hour-angle......	. .	. .	. .	. .	. .	. .
Tab. N.P.D. of object (17)....	. .	. .	. .	. .	. .	. .
P.D. from visible pole........	. .	. .	. .	. .	. .	. .
Log. sine hour-angle.........	,	,	,	,	,	,
Log. cosine latitude..........	,	,	,	,	,	,
Sum = log. sine α...........	,	,	,	,	,	,
Subtract log. sine P.D.	,	,	,	,	,	,
Log. factor in R.A.	,	,	,	,	,	,
Log. N.C. Radius..........	,	,	,	,	,	,
Log. tab. hor. eq. parallax...	,	,	,	,	,	,
Sum = log. Parallax in R.A...	,	,	,	,	,	,
	″	″	″	″	″	″
Parallax in R.A. (+ if E.)....	,	,	,	,	,	,
Log. cotan. latitude	,	,	,	,	,	,
Log. cosine hour-angle......	,	,	,	,	,	,
Sum = log. tan β...........	,	,	,	,	,	,
	° ′ ″	° ′ ″	° ′ ″	° ′ ″	° ′ ″	° ′ ″
β	. .	. .	. .	. .	. .	. .
P.D.	. .	. .	. .	. .	. .	. .
γ = P.D. − β	. .	. .	. .	. .	. .	. .
α	. .	. .	. .	. .	. .	. .
Log. cosine α..............	,	,	,	,	,	,
Log. sine γ	,	,	,	,	,	,
Log. N.C. Radius..........	,	,	,	,	,	,
Log. tab. hor. eq. parallax...	,	,	,	,	,	,
Sum = log. par. (1) in P.D....	,	,	,	,	,	,
Log. Axial Dist. of N.C.....	,	,	,	,	,	,
Log. sine P.D.	,	,	,	,	,	,
Log. tab. hor. eq. parallax...	,	,	,	,	,	,
Sum = log. par. (2) in P.D. ..	,	,	,	,	,	,
	″	″	″	″	″	″
Parallax (1) in P.D.	,	,	,	,	,	,
Parallax (2) in P.D.	− ,	− ,	− ,	− ,	− ,	− ,
Sum = Total Parallax in P.D..	,	,	,	,	,	,
Parallax in N.P.D.	,	,	,	,	,	,

NOTE.—Time is to be taken to the nearest 1ˢ.
R.A. in arc, hour-angle, P.D., α, β, γ, to the nearest 10″.
Logarithms to five decimals.
Parallaxes to 0″·01.

Computer's signature.

[FORM No. 20.] [PAGE .]

BRITISH EXPEDITION FOR OBSERVATION OF THE TRANSIT OF VENUS, 1874.

COMPUTATION OF TABULAR LOCAL DISTANCES BETWEEN THE CENTERS OF THE SUN AND VENUS, AND OF FACTORS OF CORRECTIONS TO TIME, R.A., N.P.D., AND PARALLAX.

(The quantities are entirely Tabular Local quantities. "Excess of R.A." always denotes "Excess of Tabular Local R.A. of the Center of Venus above that of the Sun." "Excess of N.P.D." always denotes "Excess of Tabular Local N.P.D. of the Center of Venus above that of the Sun." "Parallax" [meaning Horizontal Equatoreal Parallax], "Parallax in R.A.", "Parallax in N.P.D.", always denote "Excess of those quantities for Venus above the similar quantities for the Sun." The same applies to the several "Increases." The S.P.D. of Sun and Venus are, however, absolute values. "Distance between Centers" denotes "Tabular Local Distance between Centers." All logarithms are to be taken to five decimal places. To six places for "Distance between Centers.")

Station.		
No. of Observation in Form 17		
	° ′ ″	° ′ ″
S.P.D. of Sun (to 10″)	. .	. .
S.P.D. of Venus (to 10″)	. .	. .
	′ ″	′ ″
Excess of Right Ascension (to 0″·01) (+ near beginning, − near end)	− . ,	− . ,
Increase of Excess of Right Ascension in 1ˢ. (to 0″·001) (always −)	− ,	− ,
Excess of North Polar Distance (to 0″·01) (always −)	− . ,	− . ,
Increase of Excess of North Polar Distance in 1ˢ. (to 0″·001) (always −)	− ,	− ,
Parallax in R.A.	− ,	− ,
Parallax in N.P.D.	− ,	− ,
Computation of Tabular Local Distance of Centers of Sun and Venus.		
Log. sine of S.P.D. of Sun	,	,
Log. sine of S.P.D. of Venus	,	,
Sum	,	,
Half Sum (always +)	+ ,	+ ,
Log. Excess of R.A. (+ near beginning, − near end)	− ,	− ,
Sum = ϵ (sign same as for Excess of R.A.)	− ,	− ,
Subtract log. Excess of N.P.D. with sign changed (always +)	+ ,	+ ,
Log. tan. ϕ (sign same as for Excess of R.A.)	− ,	− ,
	° ′ ″	° ′ ″
ϕ (to 10″) (less than 90°, sign same as for Excess of R.A.)	− . .	− . .
Log. sine ϕ (sign same as for Excess of R.A.)	− ,	− ,
Subtract from ϵ (sign same as for Excess of R.A.)	− ,	− ,
Log. Distance between Centers (always +)	+ ,	+ ,
Log. cosine ϕ (always +)	+ ,	+ ,
Subtract from log. Excess of N.P.D. with sign changed (always +)	+ ,	+ ,
Log. Distance between Centers (always +)	+ ,	+ ,
	′ ″	′ ″
Distance between Centers (to 0″·01)	+ . ,	+ . ,

(*Continued on 2nd page.*)

Specimen of Form No. 20.

(Continued from 1st page.)

Effects of Changes of R.A., of N.P.D., and of Time, on the Distance between Centers.		
Half Sum (above)	+ ,	+ ,
Log. sine ϕ (above)	− ,	− ,
Sum = log ζ	− ,	− ,
ζ = Factor of Change of R.A. for Distance between Centers (sign as for Excess of R.A.)	− ,	− ,
Log. Increase of Excess of R.A. in 1^s. (always −)	− ,	− ,
Sum with log. ζ = log. η (− near beginning, + near end)	− ,	− ,
η (to $0''\cdot0001$)	″ − ,	″ − ,
Log. cosine ϕ (above)	+ ,	+ ,
Nat. cos. ϕ = Factor of Change of N.P.D. for Dist. betw. Cent. with sign changed (always −)	− ,	− ,
Log. Increase of N.P.D. in 1^s. (always −)	− ,	− ,
Sum with log. cos. ϕ = log. θ (always +)	+ ,	+ ,
θ to ($0''\cdot0001$)	″ + ,	″ + ,
η	− ,	− ,
$\eta + \theta$ = Increase of Distance between Centers in 1^s.	− ,	− ,
Effect of Change of Coefficient of Parallax on the Distance between Centers.		
Log. ζ (above)	− ,	− ,
Log. $\frac{1}{100}$ Parallax in R.A.	− ,	− ,
Sum = log. κ	− ,	− ,
κ (to $0\cdot0001$)	″ − ,	″ ,
Log. cos. ϕ (above) with sign changed	− ,	− ,
Log. $\frac{1}{100}$ Parallax in N.P.D.	− ,	− ,
Sum = log. λ	− ,	− ,
λ (to $0\cdot0001$)	″ − ,	″ − ,
κ	− ,	−
$\kappa + \lambda$ = Increase of Distance between Centers for $\frac{1}{100}$ Increase of Parallax	− ,	− ,

Signature of Computer.

APPENDIX V.—PHOTOGRAPHIC OBSERVATIONS of the TRANSIT of VENUS.

The apparent uncertainty in the conclusions from the photographic registers has led extensively to the persuasion that it is unnecessary to record the photographic operations with the utmost detail. But it appears proper to explain the views which directed the order of reductions, and to describe the instruments which have been employed.

The photoheliograph instruments in every case were mounted equatoreally, and it is probable that their adjustments were, as for ordinary uses, reasonably accurate. But it is impossible to place so much confidence in these adjustments, or in the insertion of the photograph-plate in the tube, as to justify the supposition that differences of R. A. and of N. P. D. between the Sun and the Planet could be measured with even moderate accuracy. The only measure upon which reliance could be placed is that of the distance between the centers of the two objects. Relying on the practicability of putting the plates fairly in position for that measure (extreme accuracy in this adjustment is not indispensable) it was only necessary to provide means of measuring accurately in one direction.

The principle of the micrometer here adopted is the following:—Two microscopes, both pointing downwards, pass through a very firm bar, 15 inches long; the tubes of the microscopes being separated about 11½ inches. (The bar, in fact, is not a solid piece of metal, but is formed like a box, with sides 2½ inches deep, and is free from sensible flexure under any ordinary strain.) The two microscopes, in this state, form a microscopic beam-compass. The beam-compass can be slid endways, with a range of nearly 8 inches, in an intermediate frame about 23 inches long, to which it can be clamped at any part of its motion; practically, however, the clamp was not used. That intermediate frame has a slot or chase extending nearly from end to end, through which the microscopes, and the bar which carries them, pass. The intermediate frame itself can be moved endways (carrying with it the beam-compass) upon the upper face of the fixed stand, by means of a fine screw at one end, carried by the fixed stand; the range of this screw is less than 1 inch. The upper part of the fixed stand is a strong plate, 24 inches long, slotted nearly from end to end, in the same manner as the intermediate frame; and the beam-compass slides endways through the slot of the intermediate frame and through the slot of the upper part of the fixed frame at the same time. The upper part of the fixed frame is carried by pillars 3 inches long fixed to the base-plate. The base-plate is 24 inches long and 7 inches broad, and it has two longitudinal perforations each about 9 inches long and 3 inches broad, with an intervening metallic cross-bar 2 inches in breadth. One of the microscopes always points downwards to one of these perforations, and the other microscope to the other perforation. The wooden structure which carries the base-plate has corresponding perforations. In use, the wooden structure is so planted above a mirror that the light of the sky is reflected upwards through the microscopes. The microscopes are now in a fit state for observing transparent objects which are laid upon the base-plate.

Over one of the perforations of the base-plate is laid the photograph, of which measures are to be taken. On the method of placing this photograph we shall speak shortly. The microscope which views the photograph, and which we shall call the "photograph-microscope," has a crossed wire, fixed in the field of view.

On the other perforation of the base-plate there is placed, in a receptacle adapted to its form, the "millimetre scale;" a scale etched on glass, graduated to 240 millimetres; its length is parallel to the length of the beam-compass. The microscope which views the scale, and which we shall call the "scale-microscope," has the usual cross-wires carried by a micrometer-screw.

This combination evidently possesses the power of measuring the distance of any part of the photograph from some part of the millimetre scale, subject to a constant correction; and therefore possesses the power of measuring the distance between any two parts of the photograph.

We now proceed to the verification of the sub-divisions of the millimetre scale. A second millimetre scale is provided, similar to the first, but containing only 64 millimetre spaces. By placing this secondary scale in different positions under the photograph-microscope, we can use different portions of the principal scale to measure the whole or any part of the secondary scale. Thus, adopting as fundamental divisions of the principal scale the Nos. 20 and 148, we could use both the spaces 20—84 and 84—148 for comparison with the whole length of the secondary scale, and thus could find the relative error of division 84. This being established, we can adopt half the length of the secondary scale, and can use with it the spaces 20—52 and 52—84 for the error of 52, and the spaces 84—116 and 116—148 for the error of 116. This process of bisection was carried on, with an extension for the first and last numbers of the scale, till the error of every graduation was determined.

The photographic plates were mounted in the measuring apparatus by the following arrangement:—The glass plates for the British Expedition were each 6 inches square; those for the Australian photographers were $6\frac{1}{2}$ inches square. Circular brass plates of sufficient thickness were prepared; that for the British photographs was $10\frac{3}{4}$ inches in diameter, and that for the Australian photographs $12\frac{1}{2}$ inches in diameter. These plates were pierced with square holes, fitted to receive the photographic glass plates, and having ledges and springs for supporting and steadily holding them. The brass-plate was laid upon the base-plate of the micrometric instrument and pushed in laterally between two guides as far as was necessary, and was held steady by a spring. As the brass plate could be turned to any position in azimuth and could be pushed in to any extent, there was no difficulty in adjusting the direction of the line to be measured so as to make it coincide with the line of the beam-compass. For so adjusting the line joining the centers of the Sun and Venus a moveable wire-frame was provided: carrying a central wire; a wire on each side parallel to it, at a distance very approximately equal to the radius of Venus; and a wire on each side at a distance very approximately equal to the Sun's radius. The wires were made tangentially to touch the two images; marks for the center wire were made on the brass plate at the place of the central wire; and the adjustment on the base-plate was made with great facility.

I now proceed to explain the use of the instrument for determining the distortion of images formed by the photoheliograph.

Some years ago, Mr. Warren De la Rue constructed for a special purpose a scale of equal parts, 15 feet in length. The frame of this scale consists of three iron tube-columns, each 15 feet long, and $\frac{5}{8}$ inch in diameter, braced together with diagonal bracings, so as to form a triangular prism 15 feet long with sides (center to center) about $12\frac{1}{2}$ inches apart. To one side of the prism are fixed eight iron plates, each 2 feet broad in the direction transverse to the length of the frame and 1 foot broad in the direction of the frame's length, with intermediate spaces of 1 foot each: it is this succession of plates and spaces which constitutes the scale of equal parts. The whole is beautifully worked. This instrument is (by Mr. De la Rue's kind permission) now preserved in the Royal Observatory.

Our first requirement was, to satisfy ourselves, by *our own* examination, that the spaces are equal, with insignificant error. For this purpose, a curtate triangle (1) was prepared, whose sides approach at the ratio of 1 approach to 12 length of side; and another frame (2) adapted to embrace

the curtate triangle in its whole height, as nearly as possible. These "trammels," as we called them, are made of sound hard oak wood, with the utmost care that carpenters could give. Definite corresponding points were adopted as those which represent very approximately on both trammels the interval 12 inches. With trammel (1) all the intervals between the plates were measured at both their extremities; and with trammel (2) the breadth of every plate was measured at the same parts. Some numerical differences were thus ascertained, totally insensible in the further use of the scale.

The scale, thus verified, was fixed above the north balustrades on the top of the Octagon Room of the Royal Observatory. By permission of the Governor of the Royal Naval College, a photograph-observatory was erected in the court of the Naval School, at a distance from the Royal Observatory (perhaps 1,500 feet) which permitted the image of the scale to occupy the greater part of the photographic plate when inserted in each of the photoheliographs. To this photographic hut was brought, in succession, each of the five heliographs used in the Transit Expedition; and images of the scale were taken, in exactly the same way as the images of the Sun with Venus in the Transit. The photographs were then inserted in the micrometer-apparatus, and were measured, for both edges of each plate of the scale. The further treatment of these measures will be best understood from the inclosed specimen of Form 22. The words and figures in italic type are copied from a real observation. It is to be remarked that five revolutions of the micrometer correspond very nearly to one millimetre.

It will be seen here that the amount of distortion is considerable. Observations were made with the tubes of the photoheliographs turned in different positions or "azimuths" round the optical axis of the telescopes, but no certain difference of distortion could be ascertained.

The total number of sheets of Form 22 is about 300. The numbers (for each instrument) for "Excess of De la Rue's Scale" were collected from the different sheets, the means for (16)—(1), (15)—(2), &c., were taken, and the results were laid down in separate curves for the five instruments. These curves were smoothed down, and their ordinates were used to give corrections for the measures of the Transit Photographs.

The following are the Corrections thus obtained by Major Tupman, applicable to the Readings in the several series of Photographs:—

Distance from Center.	Corrections to the Readings in the several series of Photographs.				
	Honolulu.	Mokattam.	Rodriguez.	Kerguelen.	Burnham.
mm.	mm.	mm.	mm.	mm.	mm.
30	+ ·063	+ ·070	+ ·080	+ ·074	+ ·076
31	+ ·062	+ ·068	+ ·078	+ ·072	+ ·074
32	+ ·060	+ ·066	+ ·076	+ ·070	+ ·071
33	+ ·057	+ ·064	+ ·074	+ ·067	+ ·068
34	+ ·055	+ ·062	+ ·071	+ ·064	+ ·065
35	+ ·052	+ ·059	+ ·067	+ ·061	+ ·061
36	+ ·049	+ ·056	+ ·063	+ ·058	+ ·057
37	+ ·046	+ ·053	+ ·059	+ ·054	+ ·053
38	+ ·042	+ ·049	+ ·054	+ ·050	+ ·049
39	+ ·038	+ ·045	+ ·050	+ ·046	+ ·045

Distance from Center.	Corrections to the Readings in the several series of Photographs.				
	Honolulu.	Mokattam.	Rodriguez.	Kerguelen.	Burnham.
mm.	mm.	mm.	mm.	mm.	mm.
40	+ ·034	+ ·040	+ ·045	+ ·042	+ ·040
41	+ ·030	+ ·035	+ ·039	+ ·037	+ ·035
42	+ ·025	+ ·030	+ ·033	+ ·032	+ ·030
43	+ ·020	+ ·025	+ ·027	+ ·027	+ ·025
44	+ ·015	+ ·019	+ ·021	+ ·021	+ ·020
45	+ ·010	+ ·012	+ ·014	+ ·015	+ ·014
46	+ ·005	+ ·006	+ ·008	+ ·009	+ ·007
47	− ·001	·000	+ ·001	+ ·003	·000
48	− ·007	− ·006	− ·006	− ·003	− ·006
49	− ·013	− ·013	− ·012	− ·010	− ·013
50	− ·019	− ·021	− ·020	− ·017	− ·020
51	− ·026	− ·029	− ·028	− ·024	− ·028
52	− ·032	− ·037	− ·036	− ·031	− ·036
53	− ·039	− ·045	− ·044	− ·038	− ·044
54	− ·045	− ·053	− ·052	− ·046	− ·052
55	− ·052	− ·061	− ·060	− ·053	− ·061
56	− ·059	− ·069	− ·069	− ·061	− ·070
57	− ·066	− ·078	− ·078	− ·069	− ·079
58	− ·074	− ·087	− ·088	− ·077	− ·088
59	− ·082	− ·096	− ·098	− ·086	− ·097
60	− ·090	− ·105	− ·108	− ·094	− ·106
61	− ·098	− ·115	− ·118	− ·103	− ·115
62	− ·106	− ·124	− ·128	− ·112	− ·125
63	− ·114	− ·133	− ·139	− ·121	− ·135
64	− ·122	− ·143	− ·151	− ·130	− ·145
65	− ·131	− ·152	− ·162	− ·139	− ·156
66	− ·140	− ·162	− ·174	− ·148	− ·167
67	− ·149	− ·172	− ·185	− ·157	− ·178
68	− ·158	− ·182	− ·196	− ·166	− ·189
69	− ·168	− ·192	− ·208	− ·175	− ·200
70	− ·177	− ·202	− ·220	− ·185	− ·210

In the application of these corrections to the measures in Form 21 (see the specimen of that Form) there is a small theoretical doubt, depending on the different focal adjustments of the photoheliograph when used on De La Rue's Scale and when used in the Transit. The easiest method of adjusting to focus is by motion of the object-glass; and in that case (see a short

investigation in the "Observatory," No. 16, Vol. ii., p. 122) the correction found from the observation of the Scale is justly applicable to the photographs of the Transit. It is believed that this mode of adjustment was always employed; and the corrections adopted in the use of Form 21 are made on that principle. If, however, the adjustment were made by altering the place of the photographic plate, a different correction would be required.

The method of so placing the photograph-plate that the centers of the Sun and Venus would be in the longitudinal line of the measuring apparatus has been described. The crossed wire of the photograph-microscope can then be placed upon the 1st limb of the Sun, the 1st limb of Venus, the 2nd limb of Venus, and the 2nd limb of the Sun. The further treatment of the photographs will be understood from the inclosed specimen of Form 21. The line "Correction for difference of irradiation" was, in fact, never used.

In some instances, the definition of the limb of Venus was not satisfactory. In particular, in the earlier observations at Mokattam (where the Sun rose with Venus on his disk) some of the images of the planet were much distorted. To obviate this, Major Tupman caused to be prepared a glass diaphragm, on which was engraved a circle somewhat smaller than the disk of Venus, and also crossed lines similar to the usual crossed wires; and measures were taken for comparing the place of intersection of the wires with the center of the circle.

The number of sheets of Form 21 employed in calculation is about 440. A portion of the measures was made by Major Tupman; the greater part, however, by Mr. Burton: no other observer was employed on them.

The clock-time of every exposure of the photoheliograph-plate for image having been noted, this time was converted into Greenwich Sidereal Time, the tabular distance of centers was computed, and the factors of the various possible errors (δn, δ R.A., δ N.P.D, δt, δR, δr) were formed, by the use of Forms 17, 18, 19, 20, exactly as for the eye-observations. The comparison of each of these tabular lines with the distance of centers found in Form 21 gave an equation. These equations were most carefully grouped by Major Tupman; and solved, by the use of proper factors, in the form most favourable to accuracy.

After laborious measures and calculations it was thought best to abstain from publishing the results of the photographic measures as comparable with those deduced from telescopic view. The considerations which led to this decision are stated by Major Tupman in a paper in the Monthly Notices of the Royal Astronomical Society, volume 38, page 508 (1878, Supplementary Notice). They are mainly embodied in this: that, however well the Sun's limb on the photograph appeared to the naked eye to be defined, yet on applying to it a microscope it became indistinct and untraceable, and when the sharp wire of the micrometer was placed on it it entirely disappeared.

A great number of photographs (216 in all) have been received from the following stations, and are entered in Form 21:—From India: Roorkee, 91. From Australia: Sydney, 60; Melbourne, 29; Woodford, 20; Eden, 16.

When the preparations for the Transit Expedition were far advanced, a proposal was published by M. Janssen for taking a photograph of Venus and a portion of the Sun's limb near to it at every second of time, or other short interval, near to the times of ingress or egress. It appeared desirable to make trial of this proposal; and, under my general superintendence, an apparatus was prepared by Mr. Dallmeyer, with great skill, which appeared likely to carry out M. Janssen's proposals perfectly well. A circular photographic glass plate, 10¾ inches in diameter, mounted in a large ring whose circumference was cut in teeth, was so arranged that, when its frame was fixed upon the photographic end of the photoheliograph, with the photographic plane transversal to the optical axis of the instrument, it could be made to rotate by a small toothed-wheel spindle (whose axis was parallel to the optical axis), but not continuously. During a portion of the rotation of the spindle the large ring and photographic plate stood still; and the plate was exposed to the Sun, and an image was formed. (This was effected by cutting away some of the spindle-teeth.) During the remaining portion of the rotation the sun-light was stopped, and the motion of the spindle gave motion to the ring and plate so as to expose a new part for a new photographic image. The winch by which the spindle was turned was very near the center of motion of the great tube; and it was found that, when turned by a careful hand, no tremor could be discovered in the photographic apparatus. The photographic images were to be measured by due adaptation of the photograph-micrometer.

The number of images thus taken and entered in Form 21 was:—At Thebes, 83; at Rodriguez, 146; at Roorkee, 53. But they have not been further reduced. The ardour of the Observers had been much cooled by the apparent general failure of the photographic principle, and they were unwilling to spend further time on these reductions.

1881, *June* 10. G. B. AIRY.

[FORM 22.]

BRITISH EXPEDITION FOR OBSERVATION OF THE TRANSIT OF VENUS, 1874.

MEASURES of the PHOTOGRAPHS of the DE LA RUE SCALE.

Reference to distinctive marks on the photograph	*Plate 297, C. Instrument.*
Photographer, and time of photographing	*Burton. 1875, August 25.*
Measurer, and time of measuring	*Burton. 1875, October 18.*
Whether at upper edge, center, or lower edge	*Upper.* *Set 2.*
Correction for error of runs on 5 (r) of micrometer	+ 0·0195 mm.

Part measured.		1st Micr. Reading.	2d Micr. Reading.	Mean.	Corr. for Div. Error. / Corr. for Runs.	Corrected Reading.
		mm. r	r	mm.	mm.	mm.
Plate 1	first edge (1)	151. 2·630	2·629	151·5259	+ ·0080 / + ·0103	151·5442
	second edge (2)	142. 3·276	3·337	142·6613	+ ·0132 / + ·0129	142·6874
Plate 2	first edge (3)	133. 3·898	3·902	133·7800	+ ·0136 / + ·0152	133·8088
	second edge (4)	124. 4·716	4·751	124·9467	+ ·0140 / + ·0185	124·9792
Plate 3	first edge (5)	116. 0·610	0·651	116·1261	+ ·0106 / + ·0025	116·1392
	second edge (6)	107. 1·683	1·756	107·3439	+ ·0075 / + ·0068	107·3582
Plate 4	first edge (7)	98. 2·794	2·812	98·5606	+ ·0092 / + ·0109	98·5807
	second edge (8)	89. 4·052	3·905	89·7957	+ ·0137 / + ·0156	89·8250
Plate 5	first edge (9)	81. 0·329	0·314	81·0643	+ ·0085 / + ·0013	81·0741
	second edge (10)	72. 1·493	1·432	72·2925	+ ·0120 / + ·0057	72·3102
Plate 6	first edge (11)	63. 2·563	2·626	63·5189	+ ·0064 / + ·0102	63·5355
	second edge (12)	54. 3·619	3·622	54·7241	+ ·0059 / + ·0142	54·7442
Plate 7	first edge (13)	45. 4·323	4·280	45·8603	+ ·0234 / + ·0168	45·9005
	second edge (14)	37. 0·280	0·284	37·0564	+ ·0299 / + ·0011	37·0874
Plate 8	first edge (15)	28. 0·830	0·831	28·1661	+ ·0092 / + ·0033	28·1786
	second edge (16)	19. 1·681	1·731	19·3412	+ ·0100 / + ·0067	19·3579

COMBINATIONS of the CORRECTED READINGS, independent of ZERO and CENTER-MEASURE.

Ranges, and their Measures.		Quotient of each Measure by the Sum.	Corresponding Quantity on De la Rue's Material Scale.	Excess of De la Rue's Scale.
	mm.			
(16) − (1)	132·1863	0·2349000	0·2343800	− 0·0005200
(15) − (2)	114·5088	0·2034864	0·2031357	− 0·0003507
(14) − (3)	96·7214	0·1718775	0·1718875	+ 0·0000100
(13) − (4)	79·0787	0·1405258	0·1406142	+ 0·0000884
(12) − (5)	61·3950	0·1091012	0·1093703	+ 0·0002691
(11) − (6)	43·8227	0·0778746	0·0781198	+ 0·0002452
(10) − (7)	26·2705	0·0466837	0·0468710	+ 0·0001873
(9) − (8)	8·7509	0·0155507	0·0156215	+ 0·0000708
Sum	562·7343	0·9999999		

Signature of Computer, *B.D.*

REMARKS: *Azimuth of Scale* ↑

70

[FORM No. 21.]

BRITISH EXPEDITION FOR OBSERVATION OF THE TRANSIT OF VENUS, 1874.

MEASURES of SOLAR PHOTOGRAPHIC IMAGES made with the PHOTOHELIOGRAPH.

Station, *Kerguelen.*

Register Mark upon the Photograph Plate, *8.*

Other Registers, *G. S. T., 8ʰ. 59ᵐ. 27ˢ·7.*

No. of Photograph in Form No. 17.

Approx. Micr. Reading for 1st edge, center, 2d edge, of Phot. Field. mm. ; mm. *87·0* ; mm.

Correction for Runs of Micrometer for 5 revolutions .... + *0ʳ·0964 and 0ʳ·1034.*

Micrometer Measures of Limbs of Sun and Venus.

Order of Measures.	1st Limb of Sun.	1st Limb of Venus.	2d Limb of Venus.	2d Limb of Sun.
1876.	mm. *31*	mm. *125*	mm. *129*	mm. *134*
Feb. 11.. 1	r *2·169*	r *4·940*	r *1·731*	r *0·414*
2	*2·232*	*4·949*	*1·663*	*0·442*
3	*2·288*	*5·004*	*1·604*	*0·370*
		126		
Feb. 12.. 4	*3·342*	*1·354*	*3·142*	*1·993*
5	*3·239*	*1·269*	*3·224*	*1·980*
6	*3·174*	*1·240*	*3·194*	*2·049*
Sums	*16·444*	*33·756*	*14·558*	*7·248*
Means	mm. *31·5481*	mm. *126·1252*	mm. *129·4853*	mm. *134·2416*
Apply mean correction for Division Error and Runs	+ *0·0152* + *0·0110*	+ *0·0132* + *0·0025*	+ *0·0085* + *0·0097*	+ *0·0132* + *0·0048*
Apparent Means corrected for Division Error and Runs	*31·5743*	*126·1409*	*129·5035*	*134·2596*
Correction for distortion	+ *0·056*	+ *0·046*	+ *0·030*	+ *0·001*
Means finally corrected	(1) *31·630*	(2) *126·187*	(3) *129·534*	(4) *134·261*
Repeat (1) under (4), and (2) under (3)...			(2) *126·187*	(1) *31·630*
Approx. dist. from center of field	*55·4*	*39·1*	*42·5*	*47·3*

Computation of the Distance of Centers of Sun and Venus.

Tabular Quantities.		Measured Quantities.	
Diameter of Sun	″ *1953·62*	(4) − (1) = Diameter of Sun	mm. *102·631*
Diameter of Venus	*62·84*	(3) − (2) = Diameter of Venus	*3·347*
Sum of Tabular Diameters	*2016·46*	Sum	*105·978*
Its logarithm (5)	*3·304590*	Correction for difference of irradiation	− 0·
Subtract log. sum of Meas. Diameters	*2·025215*	Corrected sum of Measured Diameters	·
Log. factor of scale-reading	*1·279375*	(4) + (1) = double reading for Sun's center.	*165·891*
		Sub. (3) + (2) or double reading for ♀ center	*255·721*
		Double distance of centers in mm.	*89·830*
Add log. Distance of centers in mm.	*1·65239*	Distance of centers in mm.	*44·915*
Log. Meas. Distance of centers in arc.	*2·93177*	Measured distance of centers in arc	″ *54·61*
Add log. 2	0·30103		
Add ar. co. (5)	*6·69541*		
Sum	*9·92821*	Number = Factor of (δ R + δr)	+ *0·84764*

Remarks.—*The center of field 6ᵐᵐ· below the common diameter of Venus and Sun.*

(Signature of Measurer of Photograph), *C. E. BURTON.*

(Signature of Computer), *H. P.*

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